GeoScience Abstracts

2-2776 TO 2-3140

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Vol. 2, No. 11

November 1960

published monthly by the
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GeoScience Abstracts

published monthly by the
AMERICAN GEOLOGICAL INSTITUTE

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The following list gives in full the abbreviated citations used after the titles of papers in this issue of GeoScience Abstracts.

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Geochimica et Cosmochimica Acta. London-New York.
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Indiana, Geological Survey, Circular; Directory; Report of Progress. Bloomington, Indiana.
owa State University, Engineering Experiment Station, Screenings from the Soil Research Laboratory. Ames.
ournal of Geology. Chicago.
ournal of Paleontology. Tulsa, Oklahoma.
ournal of Sedimentary Petrology. Tulsa, Oklahoma.
Kentucky Geological Survey, Information Circular. Lexington.
Keystone Newletter (Mineralogical Society of Pennsylvania). Philadelphia.
Lunar and Planetary Exploration Colloquium, Proceedings. North American Aviation, Inc., Downey, California.
Manitoba, Dept. of Mines and Natural Resources, Mines Branch, Publication. Winnipeg.
Mining Engineering (American Institute of Mining, Metallurgical and Petroleum Engineers). New York.
Mississippi State Geological Survey, Bulletin. University, Mississippi.
National Academy of Sciences, Proceedings. Washington, D.C.
National Speleological Society, Western Speleological Survey, Bulletin. [n.p.]
Nautilus. Philadelphia.
New Mexico, Bureau of Mines and Mineral Resources, Biennial Report; Bulletin; Circular; Scenic Trips to the Geologic Past. Socorro.
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Pochvovedeniye. Soviet Soil Science; a translation of a publication of the V.V. Dokuchaev Institute of Soil Science, Academy of Sciences, U.S.S.R. (American Institute of Biological Sciences). Washington, D.C.
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U.S. Geological Survey, Circular; Mineral Investigations Map; Miscellaneous Investigations Map; Professional

Paper; Reports, Open-File Series; Trace Elements Investigations Report; Water-Supply Paper. Washington, D.C.
U.S. Snow, Ice and Permafrost Research Establishment, Technical Report. Wilmette, Illinois.
Washington, Division of Mines and Geology, Report of Investigations. Olympia.
Wyoming, Geological Survey, Report of Investigations. Laramie.

DECEMBER ISSUE AND ANNUAL INDEX

The annual author and subject index for 1960 and the December 1960 issue of GeoScience Abstracts will be mailed to subscribers concurrently. The delay in mailing will be approximately one month.--Managing Editor.

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Those wishing to purchase items abstracted herein should address their orders to the agency, society, or organization indicated in the bibliographic citations preceding the abstracts, or to their local book dealer. The city and state for the serials cited are given above. The American Geological Institute, publisher of GeoScience Abstracts, regrets that it cannot fill purchase orders for abstracted publications other than its own.

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

ee also: Geomorphology 2-2845; Miscellaneous 2-3136, 3137.

2776. Belyea, Helen R. DISTRIBUTION OF OME REEFS AND BANKS OF THE UPPER DEVO-IAN WOODBEND AND FAIRHOLME GROUPS IN LBERTA AND EASTERN BRITISH COLUMBIA: anada, Geol. Survey, Paper 59-15, 7 p., Map 51-959 (in pocket), 1960, 89 refs.

Title of report explains the purpose of the map. ap also has brief descriptive notes and cross secon. Text of the paper consists entirely of references.--P. Harker.

-2777. Canada, Geological Survey. MALAGASH, UMBERLAND, PICTOU AND COLCHESTER COUNIES, NOVA SCOTIA: Its: Geophysics Paper 830, eromagnetic map, scale 1:63,360, contour intervals 0, 20, 100, and 500 gammas, lat. 45°45'-46°N., ong. 63°-63°30'W., 1960.

-2778. Canada, Geological Survey. NEW GLASOW, PICTOU COUNTY, NOVA SCOTIA: Its: Geohysics Paper 763, aeromagnetic map, scale :63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 45°30'-45°45'N., long. 62°30'-63°W., 960.

-2779. Canada, Geological Survey and Ontario, Dept. of Mines. AEROFOIL LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 870, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°30'-50°45'N., long. 92°30'-93°W., 1960.

2-2780. Canada, Geological Survey and Ontario, Dept. of Mines. BLUFFY LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 871, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 50°45'-51°N., long. 92°30'-93°W., 1960.

2-2781. Canada, Geological Survey and Ontario, Dept. of Mines. CONFEDERATION LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 872, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°-51°15'N., long. 92°30'-93°W., 1960.

2-2782. Canada, Geological Survey and Ontario, Dept. of Mines. CONOVER LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 875, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°45'-52°N., long. 92°30'-93°W., 1960.

2-2783. Canada, Geological Survey and Ontario, Dept. of Mines. HEWITT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 877, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°15'-52°30'N., long. 92°30'-93°W., 1960.

2-2784. Canada, Geological Survey and Ontario, Dept. of Mines. MacDOWELL LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 876, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°-52°15'N., long. 92°30'-93°W., 1960.

2-2785. Canada, Geological Survey and Ontario, Dept. of Mines. MAMAKWASH LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 874, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°30'-51°45'N., long. 92°30'-93°W., 1960.

2-2786. Canada, Geological Survey and Ontario, Dept. of Mines. NISKA LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 879, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°45'-53°N., long. 92°30'-93°W., 1960.

2-2787. Canada, Geological Survey and Ontario, Dept. of Mines. NORTH SPIRIT LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 878, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 52°30'-52°45'N., long 92°30'-93°W., 1960.

2-2788. Canada, Geological Survey and Ontario, Dept. of Mines. SHABUMENI LAKE, KENORA DISTRICT, ONTARIO: Canada, Geol. Survey, Geophysics Paper 873, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 1000 gammas, lat. 51°15'-51°30'N., long. 92°30'-93°W., 1960.

2-2789. Canada, Geological Survey. CHARLOTTETOWN, QUEENS COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 831, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°-46°15'N., long. 63°-63°30'W., 1960.

2-2790. Canada, Geological Survey. MALPEQUE, PRINCE AND QUEENS COUNTIES, PRINCE EDWARD ISLAND: Its: Geophysics Paper 828, aeromagnetic map, scale 1:63, 360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°30'-46°45'N., long. 63°30'-64°W., 1960.

2-2791. Canada, Geological Survey. MONTAGUE, KINGS AND QUEENS COUNTIES, PRINCE EDWARD ISLAND: Its: Geophysics Paper 836, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°-46°15'N., long 62°30'-63°W., 1960.

2-2792. Canada, Geological Survey. MOUNT STEWART, KINGS AND QUEENS COUNTIES, PRINCE EDWARD ISLAND: Its: Geophysics Paper 837, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°15'-46°30'N., long. 62°30'-63°W., 1960.

2-2793. Canada, Geological Survey. PICTOU ISLAND, QUEENS, KINGS AND PICTOU COUNTIES, PRINCE EDWARD ISLAND AND NOVA SCOTIA: Its: Geophysics Paper 835, aeromagnetic map, scale

1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 45°45'-46°N., long. 62°30'-63°W., 1960.

2-2794. Canada, Geological Survey. RUSTICO, QUEENS COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 832, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°15'-46°30'N., long. 63°-63°30'W., 1960.

2-2795. Canada, Geological Survey. SUMMERSIDE, PRINCE AND QUEENS COUNTIES, PRINCE EDWARD ISLAND: Its: Geophysics Paper 827, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°15'-46°30'N., long. 63°30'-64°W., 1960.

2-2796. Canada, Geological Survey. GULF OF ST. LAWRENCE, PRINCE COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 829, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°45'-47°N., long. 63°30'-64°W., 1960.

2-2797. Canada, Geological Survey. GULF OF ST. LAWRENCE, QUEENS COUNTY, PRINCE EDWARD ISLAND: Its: Geophysics Paper 833, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°30'-46°45'N., long 63°-63°30'W., 1960.

2-2798. Canada, Geological Survey. GULF OF ST. LAWRENCE: Its: Geophysics Paper 834, aeromagnetic map, scale 1:63,360, contour intervals 10, 20, 100, and 500 gammas, lat. 46°45'-47°N., long. 63°-63°30'W., 1960.

2-2799. Dibblee, Thomas W., Jr. GEOLOGIC MAP OF THE BARSTOW QUADRANGLE, SAN BERNARDINO COUNTY, CALIFORNIA: U.S. Geol. Survey, Mineral Inv. Map MF-233, scale 1:62,500, contour interval 40 ft., lat. 34°45'-35°N., long. 117°-117°15'W., 1960.

2-2800. Cornwall, Henry R., and Frank J. Kleinhampl. PRELIMINARY GEOLOGIC MAP OF THE BARE MOUNTAIN QUADRANGLE, NYE COUNTY, NEVADA: U.S. Geol. Survey, Mineral Inv. Map MF-239, scale 1:48,000, contour interval 40 ft., lat. 36°45'-37°N., long 116°30'-116°45'W., 1960.

2-2801. Gibbons, Anthony B., E. Neal Hinrichs, Wallace R. Hansen, and Richard W. Lemke. PRELIMINARY GEOLOGIC MAP OF THE TIPPIPAH SPRING NW QUADRANGLE, NYE COUNTY, NEVADA: U.S. Geol. Survey, Trace Elements Inv. Rept. 754, 2 map sheets (1 map and legend sheet in pocket, scale 1:24,000, contour inverval 20 ft.), [1960].

2-2802. Holzle, Alvin F. PHOTOGEOLOGIC MAP OF THE CABEZON-3 QUADRANGLE, McKINLEY AND SANDOVAL COUNTIES, NEW MEXICO: U.S. Geol. Survey, Misc. Inv. Map I-317, scale 1:62,500, lat. 35°30'-35°45'N., long. 107°15'-107°30'W., 1960.

2-2803. U.S. Geological Survey, Military Geology Branch. ENGINEER SPECIAL STUDY OF THE SURFACE OF THE MOON. Prepared for the Office of the Chief of Engineers: 4 sheets (3 map sheets, text-table sheet), scale approx. 1:3,800,000, Washington, D.C., U.S. Army Map Service, July 1960.

This study was prepared under the direction of the Office of the Chief of Engineers by the Military Geology Branch, U.S. Geological Survey. The project chief was Arnold C. Mason, and the photogeologic research and compilation were by Robert J. Hackman. The study is based on a photogeologic analysis using stereoscopic vision to examine photographs which have been matched to select libration pairs approximately in the same lunar phase. A photomosaic of the moon, printed in subdued halftone on appropriate maps, provides a base for reference.

The sheet, "Physiographic Divisions of the Moon," divides the moon into regions, based on degree of similarity or difference in type of surface features, extent of preservation, type of modification, type of surface material, elevations, slopes, and structural disturbances. The major divisions of the moon consist of the Lunar Highlands containing thousands of craters, and the Lunar Lowlands consisting of the maria and associated features.

The "Generalized Photogeologic Map of the Moon," divides the rock formations on the surface into Pre-Maria, Maria, and Post-Maria age. This map also identifies individual impact craters and indicates whether or not the crater has a central peak or mountain. The contacts between the types of rocks are delineated, and symbols indicate structural features such as faults or fractures, anticlines, monoclines, and other features of possible geologic significance.

The "Lunar Rays" map shows the principal lunar rays, many of which are so prominent they are observable at full moon with binoculars. They are interpreted as splashes of condensed vapor and comminuted material thrown from the crater of origin. The table contains a description and evaluation of the physiographic regions.

In summary, considering the factors of the environment, and the appearance under stereoscopic vision, the Lunar Highlands are interpreted as an almost endless succession of contiguous, overlapping, and superimposed impact craters composed of unsorted, coarse, and partly blocky material. The Lunar Lowlands are interpreted as relatively level plains with minor, low ridges, some rilles and escarpments, randomly scattered Post-Maria craters, and some islandlike highland areas. The surface of the lava is probably mostly smooth, but in part rough and clinkery.--L.M. Dane from text, sheet [4].

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Stratigraphy 2-2859; Mineralogy 2-3032; Geohydrology 2-3079; Mineral Deposits 2-3088.

2-2804. Blackadar, Robert G., and J.A. Fraser. PRECAMBRIAN GEOLOGY OF ARCTIC CANADA, A SUMMARY ACCOUNT: Canada, Geol. Survey, Paper 60-8, 24 p., secs., chart, table, 1960, 32 refs.

Consists of 2 separate papers dealing respectively with the Arctic Archipelago (Blackadar, p. 1-11) and the arctic mainland (Fraser, p. 12-24). Precambrian rocks of the Archipelago are a northern extension of the Canadian Shield; they occupy much of Baffin Island and occur in the structural highs of Boothia Peninsula, Somerset Island, and Victoria Island, and to a lesser extent on the eastern fringes of the Queen Elizabeth Islands. Two broad divisions into Archean (mainly gneissose rocks) and Proteroc (mainly sedimentary rocks) can be recognized. ystem of unaltered basic dikes cuts all rocks older h Paleozoic. The same broad divisions are seen the mainland, where the Archean rocks also in- de 2 major phases of granitic intrusion. Six dis- ct areas of Proterozoic are described, and the ks are assigned to a number of named groups and mations. All rocks are cut by basic intrusions, there are other, mainly basic, bodies associated h the Proterozoic rocks of uncertain age. Au, U, and Cu are produced from Precambrian rocks on arctic mainland. Lesser amounts of other min- ls have been reported. Areas of potential Fe ore ur on Baffin Island.--P. Harker.

805. Stuart, R.A. GEOLOGY OF THE KE- NO-TAHTSA AREA: British Columbia Dept. nes, Bull. 42, 52 p., geol. map, 15 diags., 1960, refs.

The area described lies 370 mi. NW. of Vancouver $^{o}30'$-$53^{o}45'$N. $127^{o}30'$-$128^{o}00'$W.) on the E. flank the Coast Mountains and at the eastern boundary the Coast Range batholith. The oldest rocks are e-Middle Jurassic igneous rocks exposed in a dome the central part of the map-area. They comprise atholithic complex of dioritic rocks intruded by artz diorite and granodiorite dikes and quartz nzonite stocks and are overlain unconformably by ddle (and Lower?) Jurassic volcanic and sedimen- y rocks. In the eastern part of the area, the assic strata are unmetamorphosed and are over- n unconformably by Lower Cretaceous sandstones d shales. In the western part, the Jurassic strata ve undergone a low-grade regional metamorphism, lowed by contact metamorphism adjacent to young- igneous intrusives.

The younger intrusives include a quartz diorite eiss, that probably represents a border phase of e main body of the Coast intrusions, and a number granitic masses of varying sizes that range in mposition from hornblende gabbro to albite granite. e of these, a dike 8 mi. long and up to 1 1/2 mi. de, is differentiated and consists of a central zone quartz diorite and border zones of diorite. Chem- al analyses of a number of specimens of granitic cks are presented in an appendix to the report.

A hydroelectric development completed by the uminum Company of Canada in 1954 required the moval of nearly 3 1/2 million tons of rock from derground excavations within the map-area. The ology of these excavations and the effects of the ological environment on the progress of the ex- vations are the subject of a short chapter on en- neering geology.--Auth.

2806. Milligan, G.C. GEOLOGY OF THE LYNN AKE DISTRICT: Manitoba, Dept. Mines & Nat. Re- urces, Mines Branch, Pub. 57-1, 317 p., 14 illus., maps (16 under separate cover), chart, 9 secs. under separate cover), 10 diags., 1960, refs.

The Lynn Lake District, an area of 3,600 sq. mi. the Precambrian of Manitoba, is underlain by in- rbanded volcanic and sedimentary rocks of the asekewan series which was severely folded and in- ded by pre-Sickle intrusive rocks (gabbro to gran- e) prior to deposition of the conglomerate and feld- athic sandstone of the Sickle series. Post-Sickle lding affected all the earlier rocks and was followed intrusions ranging from diorite to granite and gmatitie.

The complex folding and apparent cross-folding of e Sickle series is explained as deformation of a single age and extending for several miles on either side of a narrow zone which moved NE. Granitic rocks occupy the central part of the area of the Sickle rocks; related high-grade regional metamorphism of the Sickle series has formed "Kisseynew-type" gneisses.

The Lynn Lake Cu-Ni mines are in gabbro plugs; some ore lies in diorite and quartz diorite which represent later units of the pre-Sickle intrusive group. All 3 types are ore-bearing. A zone of brecciation which itself had been displaced by a number of faults was the site of sulfide deposition. The pyrrhotite, chalcopyrite, and pentlandite are thought to have been introduced long after the consolidation of the gabbro. Several post-Sickle Au deposits are present in the area. No valuable silicate minerals are known to be present in the pegmatite bodies.--Auth.

2-2807. Gastil, Gordon, and David M. Knowles. GEOLOGY OF THE WABUSH LAKE AREA, SOUTHWESTERN LABRADOR AND EASTERN QUEBEC, CANADA: Geol. Soc. America, Bull., v. 71, no. 8, p. 1243-1254, 4 maps, sec., 2 tables, Aug. 1960, 23 refs.

Wabush Lake, Labrador, is situated a few miles from where the unmetamorphosed younger Precambrian strata of the NW.-trending Labrador geosyncline are truncated by the SW.-trending structures of the Grenville orogenic province. Field mapping and lithologic comparisons show that the metasedimentary rocks exposed within this portion of the Grenville province can be correlated with the unmetamorphosed strata of the Labrador geosyncline.

The distinctive stratigraphic units of the Wabush Lake area are quartzite, marble, muscovite and kyanite schists, and Fe formation of carbonate, silicate, and oxide facies. The principal ores of the Fe formation are martite-magnetite-quartz rock and specular hematite-quartz rock. Facies of regional metamorphism range from epidote amphibolite near the postulated "Grenville front" to granulite and migmatite farther S.

Superimposed folding throughout the area can be explained as the impression of Grenville province deformation upon earlier structures of the Labrador geosyncline.--Auth.

2-2808. Priddy, Richard Randall. MADISON COUNTY GEOLOGY: Mississippi State Geol. Survey, Bull. 88, 123 p., 35 illus., 6 maps (4 fold.), 3 secs. (2 fold.), 1960, 25 refs.

Madison County is just SW. of the center of Mississippi. It is crossed from NW. to SE. by 3 physiographic belts: North Central Hills underlain by Cockfield [Eocene] sands and clays in the NE.; Jackson Prairie developed on the massive Yazoo [Eocene] clay in the center and in the SW.; and Vicksburg Hills carved from Oligocene limestones, marls, clays, and sands in the SW. and in the extreme S. A fourth belt, the Loess Hills, is developed in the NW. where a blanket of windblown silt is being eroded.

In the NE. part of the county, Cockfield beds have been faulted in a broad NW.-SE. belt characterized by parallel grabens and horsts. Oil and gas have been trapped against 2 of the faults at considerable depths, as in Pickens and Loring fields, so it is possible that other surface structures in the same belt may also provide traps that will produce. Scattered surface anomalies in other parts of the county deserve detailed investigation.

Surface strata contain beds of probable economic value: carbonaceous clays for brick; gray, silty clays for tile and brick; glauconite for soda, potash, and phosphate fertilizer; and limestone for agricultural use. Exposures of thin bentonitic clays may be indicative of thicker surface or near-surface clays which can be used for filtering. Shallow Cockfield sands and deeper Sparta [Eocene] sands furnish abundant water.

This report is illustrated with maps showing physiography, stratigraphy, and structure. Two cross-sections show the details of stratigraphy and structure.--Auth.

2-2809. Parks, William Scott, B.E. Ellison, and E.H. Boswell. PRENTISS COUNTY GEOLOGY, by William Scott Parks; GROUND WATER RESOURCES OF PRENTISS COUNTY, by B.E. Ellison, and E.H. Boswell: Mississippi State Geol. Survey, Bull. 87, 110 p., 44 p., 21 illus., 8 maps (4 fold.), 2 fold. profiles, 2 charts, 2 fold. secs., 2 graphs, 10 tables, 1960, approx. 50 refs.

The county contains parts of 3 physiographic divisions: the Tombigbee and Tennessee River hills, a rugged to rolling surface sloping generally to the W.; the Black Prairie belt, a low-lying area of slight to moderate relief and gently rolling hills; and the Pontotoc Hills, a rugged to rolling upland of moderate to high relief. Numerous creeks, branches, and tributaries that drain the area are a part of 3 major river systems, the Tombigbee, the Mississippi, and the Tennessee. The climate is warm and temperate. Vegetation and soils contrast markedly among the sandy Tombigbee and Tennessee River hills and the Pontotoc hills divisions, and the calcareous Black Prairie belt division.

Bedrock formations exposed in the county area are, for the most part, of sedimentary marine origin and are a part of the Gulf series of the Cretaceous system. These units are, in ascending order: the Gordo, the McShan, the Eutaw, the Coffee, the Demopolis, and the Ripley formations.

Only a suggestion of the Gordo formation is at the surface; however, test hole records reveal that the formation consists of sand and gravel with some clay beds. The only test hole drilled through the entire Gordo found a thickness of 87 ft.

The McShan formation, which is somewhat poorly exposed, is chiefly laminated fine sands and silts with some laminae of clay. It has a maximum thickness of 28 ft. in surface exposures.

The Eutaw formation is composed of 2 units: a lower part, generally cross-bedded glauconitic sands containing laminae of clay and some scattered chert gravel, and thin-bedded sands interbedded with laminated layers of clay-shale; and an upper member, the Tombigbee sand, a massive, very glauconitic, more or less calcareous, in part fossiliferous sand containing some concretionary layers of calcareous sandstone. The lower part of the Eutaw ranges in thickness from 110 to 170 ft. and the Tombigbee sand member from 75 to 85 ft.

The Coffee formation is made up chiefly of sands, silty sands, sandy silts, and some clay beds and shale. It contains several layers of concretionary calcareous sandstone and a few bentonite beds. Some parts are fossiliferous. It ranges in thickness from 240 to 275 ft.

The Demopolis formation is a fossiliferous impure chalk containing variable amounts of clay, silt, and sand. Generally it is sandy at its base and increasingly argillaceous toward the top. It varies in thickness from 230 to 235 ft.

The Ripley formation is represented by 3 units: a basal transitional clay, consisting of fossiliferous, calcareous, sandy clay ranging in thickness from 40 to 45 ft.; the Coon Creek tongue, composed of 165 to 180 ft. of sands, marl, clay beds, and some sandstone; and the McNairy sand member, represented by ferruginous sandstone ledges and sand ranging in thickness from 80 to 90 ft.

Surficial deposits of Quaternary age include alluvium, terrace deposits, loessal materials, colluvium, residuum, and soils.

The general structural configuration is homoclinal with a regional dip which averages 30 ft. per mi. to the W. No major surface faults or structures were found.

The geologic history of the rock formations is limited to the events connected with these bedrock deposits of Upper Cretaceous age.

Mineral resources of the county are bentonite, clay, chalk, sand and gravel, and possibly oil and gas.--Auth.

Prentiss County, in northeastern Mississippi between Corinth and Tupelo, is underlain by formations of calcareous clay, shale, sand, and gravel ranging in age from Late Cretaceous to Recent. Except for the Quaternary deposits which are found beneath the terraces and flood plains of the streams and which supply water to many of the shallow dug wells, all the water-bearing units are in the Upper Cretaceous series. The formations dip to the W. toward the axis of the Mississippi embayment; the movement of ground water is generally to the SW.

The Coffee sand and sands of the Eutaw formation are the principal sources of ground water in the county. The Gordo formation is the source for 2 flowing wells used for irrigation in the lowlands of Big Brown Creek, and it is a potential source of water in an area of about 3 townships in southeastern Prentiss County. The water from the Gordo contains undesirable quantities of Fe for certain uses. The Gordo is overlapped by the Eutaw formation and is very thin or absent in most of the county.

Ground water has not been extensively developed in this county. The withdrawals at Booneville and Baldwyn combined average less than 1 million gallons a day. Only a small decline in water level has been recorded. In chemical quality all the waters are generally good for many uses, although Fe removal may be necessary for certain uses.

This report includes among other things a tabulation of data for 370 wells, chemical analyses of water samples from 24 selected wells throughout the county, and a map showing the location of the wells. --Auth.

2-2810. Montgomery, Arthur, and Patrick K. Sutherland. TRAIL GUIDE TO THE UPPER PECOS: New Mexico, Bur. Mines & Mineral Resources, Scenic Trips to the Geologic Past no. 6, 83 p., 44 illus., 2 maps (in pocket, incl. geol. map, scale 1:63,360), 22 figs., 9 diags., 1960, 8 refs.

Most of the geologic features of the sportsman- and tourist-frequented Upper Pecos Valley occur along 12 principal riding and hiking trails (including 20 mi. of State Highway 63 between Pecos and Cowles in this canyon-and-peak country of the southern Sangre de Cristo Mountains. The trail-described area extends from Tererro and Cowles in Pecos Valley to the 13,100-ft. Truchas Peaks. Outcrops along the trails are of Precambrian quartzite, amphibolite, mica schist, phyllite, granite, pegmatites, and quartz veins; Mississippian (and older?) sandstones, nglomerates, and limestones; and a thick sequence Pennsylvanian strata. A great unconformity parates the Precambrian and Mississippian-Pennvanian rocks and is shown by local remnant hills, lleys, and ancient buried soils.

Major younger structures trend N.-S.; the Paleoic strata dip westward from an anticline near Elk untain into a syncline several miles W. of the cos River and are there abruptly terminated ainst a 30-mi.-long fault. To the W. and N., Prembrian rocks, in a second anticline, have been faulted thousands of feet to form the lofty glaciated, esent-day peaks of the Truchas Range. Precamian structures of the oldest regionally metamorosed metasedimentary rocks trend mainly E.-W.; ese structues have been modified and partly oberated by basic intrusives (metamorphosed to nphibolite) and by later unmetamorphosed granite the S. and W. parts of the area.

Features seen along the trails and highway inude the remains of the Pecos Zn-Pb-Cu mine; merous cirques, moraines, and tarns; the Precamrian-Paleozoic unconformity; caves in the Missisippian and Pennsylvanian limestones; well-preserved ssils, such as brachiopods and horn corals, in the ennsylvanian rocks; and in the Precambrian rocks cellent euhedral crystals of tourmaline, staurolite, arnet, and mica.--F.E. Kottlowski.

-2811. Corpus Christi Geological Society. **ANUAL FIELD TRIP, MAY 8-9, 1959. CORPUS HRISTI TO DEL RIO:** 60 p., 26 pls. incl. illus., aps [Corpus Christi, Texas, 1959], refs.

Emphasis of this field trip was on the upper Rio rande embayment and the Edwards formation (Low Cretaceous). Contents of the guidebook are as llows:

Generalized Geologic Section, Cenozoic of South exas, p. 1.
Road Log - First Day. Freer to Del Rio, p. 2-15.
Generalized Geologic Section, Cretaceous of outhwest Texas, p. 16.
Road Log - Second Day. Del Rio to San Antonio, . 17-35.
Some Notes on Formations Covered on the Trip, . 36-43.
Reports on a Few of the Typical Fields of the rea, p. 44-60.
  Fashing (Edwards) Field, Atascosa County, Texas, by George R. Pinkley, p. 44-46.
  Wintergarden Field, Dimmit County, Texas, by Field Trip Committee, p. 47-48.
  Jackpot Field, Maverick County, Texas, by Edward M. Warren, p. 49-52.
  Preliminary Notes on Stuart City Field, La Salle County, Texas, by Porter Montgomery, p. 53-60.

-2812. Corpus Christi Geological Society. **TENTH NNUAL FIELD TRIP. GEOLOGY OF THE CHITTIM RCH AND THE AREA NORTH TO THE PECOS RIVER, APRIL 29-30, 1960:** 47 p., 12 pls. incl. illus., aps, secs., [Corpus Christi, Texas, 1960], refs.

This field conference covered parts of Maverick, inney, and Val Verde counties. Contents of the uidebook are as follows:

Road Log for First Day - Chittim Anticline, p. -4.
Sacatosa Field, p. 5.
Road Log for Second Day - Eagle Pass to Pecos River, p. 6-11.
Geology of the Chittim Anticline, Maverick County, Texas, by John R. Bunn, p. 12-31.
Paleozoic Geology of the Delaware and Val Verde Basins, by Charles Vertrees, C.H. Atchison, and Glen L. Evans, p. 32-41.
Index Fossils of the Trans-Pecos Area, by Keith Young, p. 42-47.

2-2813. Foutz, Dell R. **GEOLOGY OF THE WASH CANYON AREA, SOUTHERN WASATCH MOUNTAINS, UTAH:** Brigham Young Univ., Dept. Geology, Brigham Young Univ. Research Studies, Geology Ser., v. 7, no. 2, p. 1-37, illus., 3 maps, chart, 2 secs., Apr. 1960, 43 refs.

The Wash Canyon area covers 16 sq. mi. in central Utah including parts of the Middle Rockies and Great Basin provinces. The mountain portion is part of the southern Wasatch mountains, and the basin portion is in Juab Valley.

Approximately 6,000 ft. of Paleozoic marine sediments are exposed in the area. In some sections the sequence is covered with an unknown thickness of Tertiary, Quaternary, and possibly Upper Cretaceous material, mostly coarse clastics.

Pre-Laramide normal faults cut the area in a general E.-W. direction but most of the deformation resulted from the Laramide orogeny. The sole of the Nebo thrust probably underlies the Wash Canyon area and represents movement during Late Cretaceous time. The area experienced N.-S. folding during Eocene and Oligocene time, and N.-S. normal faulting from Pliocene to Recent time. The Wasatch fault is a part of this last event.

Water, gravel, and calcite deposits are the only economic resources in the area at present. Early prospecting for Pb and Ag failed to locate any important metallic mineral deposits.--Auth.

2-2814. Haydon, Rosa Navarro, and Mortimer D. Turner. **ROAD LOG AND GUIDE FOR A GEOLOGIC FIELD TRIP THROUGH CENTRAL AND WESTERN PUERTO RICO:** Geology Club Puerto Rico, Bull. 1, 89 p., illus., map, 1959, 53 refs.

This guidebook was prepared primarily for use by the delegates to the Second Caribbean Geologic Conference held at Barrio Rosario, Mayagüez, Jan. 4-9, 1959. However, it is arranged and written so that it may be used by any person interested in the natural history of Puerto Rico. Numerous stops are indicated that are not part of the itinerary of the conference field trip, and geology along certain alternate routes and side roads is mentioned. The guide covers a trip from the San Juan area to Mayagüez by way of Camuy, San Sebastián, and Añasco, with a return trip to San Juan through Ponce and Barranquitas.--From introd.

The guidebook consists of the following sections: natural history (central mountain ranges, coastal plains, playa plains, geologic history, fauna); the Puerto Rican people; and 6 road logs (International Airport to Manatí; Manatí to Arecibo; Arecibo to Rosario; Mattson trip; Rosario to Ponce; Ponce to Bayamón).

2-2815. Walper, Jack L. **GEOLOGY OF COBÁN-PURULHÁ AREA, ALTA VERAPAZ, GUATEMALA:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 8, p. 1273-1315, 3 illus., 6 maps, 5 secs., chart, Aug. 1960, 34 refs.

The Cobán-Purulhá area, comprising approximately 400 sq. mi. in central Guatemala, lies in the folded and faulted front ranges of the Antillean Mountain system which extends eastward from Chiapas, Mexico, across Guatemala, and into the Caribbean Sea.

The outcropping rocks are of Paleozoic and Mesozoic age. The Tactic and Chochal formations consisting lithically of shale and limestone, respectively, are of Permian age and comprise the oldest stratigraphic sequence. Unconformably overlying the Chochal formation is a sequence of continental deposits, the Todos Santos formation, of Jurassic-Cretaceous age. These are conformably overlain by a thick limestone sequence of Cretaceous age which is subdivided into the lower Ixcoy formation and the upper Cobán formation.

Nomenclatorial problems encountered were dealt with by proposing the new name Tactic for lower Permian shales which have been erroneously called Santa Rosa, discarding the name Santa Rosa in favor of Todos Santos for the continental beds, and the redefinition of the Ixcoy and Cobán formations.

Folding has produced, in addition to a large E.-W.-trending anticlinorium, a number of complexly fractured anticlines and synclines. The area is cut by a zone of major E.-W. faulting which appears to align with the N. boundary fault of the Cayman trench (Bartlett trough) in the Caribbean Sea.

The thick sequence of limestone, which has been extensively fractured where folded, together with the heavy rainfall, has given rise to an exceptionally well developed karst topography.--Auth.

2. GEOMORPHOLOGY

See also: Paleontology 2-2884; Geophysics 2-2942, 2-2988; Sedimentary Petrology 2-3046, 2-3047, 2-3048, 2-3050.

2-2816. Crary, A.P. ARCTIC ICE ISLAND AND ICE SHELF STUDIES, PART II: Arctic, v. 13, no. 1, p. 32-50, 3 maps, 6 diags., 3 tables, March 1960, 28 refs.

An outline is given of the possible history of the thick ice islands and ice shelves in the Arctic Basin, based on surface and subsurface features described in Pt. I [Arctic, v. 11, p. 2-42, 1958]. From heat flow considerations, the time necessary to grow ice 60 m. thick by freezing at the lower boundary is 500 years, providing the accumulation or ablation at the surface is negligible and heat is not contributed by the ocean waters. A study of Arctic Ocean currents indicates that the heat now being brought into the Arctic Basin would limit present ice growth to 12 m. The C^{14} age results from samples of wind-blown dirt from the islands, and from driftwood and marine shells along the shore of northern Ellesmere Island give conflicting evidence of age from 3,000 to 7,000 years, but show definitely that the ice has grown since the Wisconsin ice age, presumably by freezing from the bottom and accumulation at the surface in about equal amounts. The characteristic "rolls" of the ice shelf are believed to result from elongation of melt ponds from the action of strong prevailing winds over many centuries.--Auth.

2-2817. Nobles, Laurence H. GLACIOLOGICAL INVESTIGATIONS, NUNATARSSUAQ ICE RAMP, NORTHWESTERN GREENLAND: U.S. Snow, Ice & Permafrost Research Establishment, Tech. Rept. 66, 57 p., 45 figs. incl. 23 illus., 5 maps, secs., profiles, diags., graphs, 9 tables, 1960, 34 refs.

The margin of the ice cap in northwestern Greenland is formed by a relatively thin ice carapace resting on a very rugged sub-ice topography. The Nunatarssuaq ice ramp is a gently sloping ice mass approximately 4 mi. long by 2 mi. wide that forms part of this margin 30 mi. NE. of Thule.

The ice of the Nuna ramp is of subpolar type, in which negative temperatures prevail throughout most of the year in all but the upper few feet. At a depth of 25 ft. the ice temperature is constant throughout the year at -14°C.; only the upper 2-3 ft. of ice is at 0°C. by the end of the melt season. Thus the temperature regimen of this high-polar ice is strictly analagous to that of perennially frozen ground. All runoff is on the surface, forming such surface features as slush avalanches, algal pits, and an integrated drainage pattern.

Net accumulation as high as 25 in. of water equivalent was measured at Morris Station, 30 mi. from the border of the ice cap, but most of the Nuna ramp proper is blown free of snow in winter by strong winds. Ablation of 20 to 25 in. of water during the melt season is common on the lower Nuna ramp. The most severe ablation is on days of moderately high temperature accompanied by moderate winds. The firn limit on the ramp is at about 3,000 ft. elevation. Comparison between the total amount of ice ablated from the lower ramp and the amount delivered to the ramp by flow through the gap S. of Nuna knob indicates a strongly negative budget balance for the ramp during the period studied.

Velocity of ice movement on the Nuna ramp is 1 to 2 in. per day. Level measurements indicate that the angle of the movement vector never differs from the horizontal by more than 5°. Calculations of the amount of movement of ice toward the surface to replace that lost by ablation also indicate a strongly negative budget balance and suggest complete decay of the ramp in 300 to 600 years under present climatic conditions.

Deformation of the ice during flow has formed a number of metamorphic structures of both tensional and shear origin. These include foliation; blue bands up to 20 ft. thick; amber bands, consisting of unequally distributed, finely divided debris; joints; small crevasses; and ice dikes.--Auth. summ.

2-2818. Haumann, Dieter. PHOTOGRAMMETRIC AND GLACIOLOGICAL STUDIES OF SALMON GLACIER: Arctic, v. 13, no. 2, p. 76-110, 11 illus., 3 maps (col. geol. map, scale 1:25,000, in pocket), 3 profiles, 5 diags., 14 tables, June 1960, 17 refs.

The National Research Council of Canada participated in the second University of Toronto expedition to the Salmon Glacier region in northern British Columbia in the summer of 1957 by sending a geodesist-glaciologist from the Photogrammetric Research Section. Glacier studies must be based on quantitative data obtained from a proper surveying and mapping of the glacier, for which ordinary surveying methods are impractical. Terrestrial photogrammetry has been used in the past. The author made one of the first attempts to apply aerial photogrammetric methods systematically to obtain measurements important in glacier research. He discusses e establishment of the ground control network, ight planning, photogrammetric operations and valuation, and the glaciological-topographical studes carried out in the field and from aerial photoraphs. A brief discussion is given of the method nd results of terrestrial photogrammetry, which as used only for 3 velocity base lines. A 7-color laciological map of the Salmon Glacier at a publicaon scale of 1:25,000 forms part of the paper.--T.J. lachut.

-2819. Ragle, Richard H., and others. **ORE DRILLING IN THE ROSS ICE SHELF, LITTLE MERICA V, ANTARCTICA**: U.S. Snow, Ice & Perafrost Research Establishment, Tech. Rept. 70, 0 p., 4 diags., 6 tables, 1960.

Drilling operations and core and drill-hole investiations at Little America V in Oct.-Dec. 1958, as ell as measurements at Byrd Station in Dec. 1958 re discussed. The hole at Little America V reached 36 ft., and core recovery was 98% of the footage rilled. No saline ice was found in the bottom core, ndicating that the bottom ice is melting. In detailed tratigraphic studies made to a depth of 53 m., summer snow deposits were coarse grained and often ssociated with icy crusts, ice layers, and glands. Winter deposits were finer grained, more homogeneus, and lacked the soaked appearance of summer now. Periods of 2-3 consecutive years at more or ess regular intervals of 10-20 years showed intense ce formation. Layers of foreign material, tentaively identified as volcanic ash, were observed at 72.1 m., 219.4 m., and 222.8 m. The depth-density urve steepened between 20.7 and 36.5 m. If annual recipitation is estimated as 21 cm. of water, Little America V rests on about 1,225 years of accumulated now. Data (some of a preliminary nature) are tablated and graphed: the depth-density profile to a epth of 53 m., the nature of ice at various depths, spot densities below 53 m., and the annual increments at depth and corresponding water equivalents t Little America V; ice temperature at various depths at both stations; and depth-inclination measurements as well as the diam.-vs-depth curve at Byrd Station. The future research program at Little America V is outlined.--Auth. summ.

2-2820. Craig, B.G., and J.G. Fyles. **PLEISTOCENE GEOLOGY OF ARCTIC CANADA**: Canada, Geol. Survey, Paper 60-10, 21 p., 6 maps, table, 1960, 33 refs.

Pleistocene epoch in arctic Canada involved a succession of 2 or perhaps 3 glacial and interglacial intervals. Some areas were apparently not overridden by ice during the latest (Wisconsin) invasion.

Pre-Wisconsin surficial features are mainly found outside the areas of Wisconsin glaciation, on the western Queen Elizabeth Islands, Banks Island, and on the arctic coastal lowlands of the Mackenzie River and Yukon basin. The Beaufort formation of late Tertiary or earliest Pleistocene age is very widely distributed and may be equivalent to the Gubik formation of the Alaska coastal plain and the various unconsolidated sands, silts, and gravels of the arctic coastal lowlands. Within the area covered by the Wisconsin Laurentide ice sheet there are many striking glacial features including molded rock surfaces, crag-and-tail hills, esker complexes, and raised shorelines. A distinct pattern of deglaciation can be recognized with many proglacial lakes. Sea level changes, readily observed from beach deposits and marine shells, record the uplift during and following the wastage of the last major glaciation. Available radiocarbon datings in arctic Canada are given in summary in a table.--P. Harker.

2-2821. Zumberge, James H. **CORRELATION OF WISCONSIN DRIFTS IN ILLINOIS, INDIANA, MICHIGAN, AND OHIO**: Geol. Soc. America, Bull., v. 71, no. 8, p. 1177-1188, map, table, Aug. 1960, 53 refs.

Three Wisconsin age glacial lobes, the Lake Michigan, Saginaw, and Erie, extended into northern Illinois, northern Indiana, and northern Ohio. The maximum advance of these 3 lobes is considered to be the Minooka moraine of the Lake Michigan lobe, the Iroquois Packerton moraines of the Saginaw lobe, and the Union City moraine of the Erie lobe. The writer considers that these moraines mark the Cary drift border in Illinois, Indiana, and Ohio. This conclusion is at variance with the interpretations of Wayne and Thornbury in Indiana, Martin in Michigan, and Goldthwait in Ohio.

The retreatal history of these 3 lobes involves a correlation of moraines and other evidence heretofore considered separately for each lobe. The position of the ice front during the release of meltwater, which produced the Kankakee torrent in Indiana and Illinois, is significant in the history of all 3 lobes. The tracing of drainage channels which carried the Kankakee meltwater in southern Michigan and northern Indiana provides the evidence for locating the ice margin of the 3 lobes during the first phase of their retreatal history. Field evidence shows that both the Lake Michigan and Erie lobes readvanced across terrain formerly occupied by Saginaw lobe ice after the maximum discharge of the Kankakee torrent. The ice position at this time is marked by the Tekonsha moraines of the Lake Michigan and Saginaw lobes and a drift border on the northwestern side of the Erie lobe in Michigan which has been traced for a distance of only 12 mi. The relationship of the border between drift of the Erie lobe and drift of the Saginaw lobe to the several moraines of the Erie lobe in Michigan, Indiana, and Ohio is not known.

In order to clarify existing late Wisconsin stage terminology the writer proposes that the moraines of the Lake Michigan lobe from, and including, the Minooka N. to, but not including, the Port Huron, be used as a type area for the Cary glaciation.

Radiocarbon dates are considered to be a means of establishing an absolute chronology of events that is based on independent field evidence and not as a primary tool for deciphering Pleistocene chronology. --Auth.

2-2822. Lawrence, Donald B., and Elizabeth G. Lawrence. **RECENT GLACIER VARIATIONS IN SOUTHERN SOUTH AMERICA**: Am. Geog. Soc., Southern Chile Exped., 1959, Tech. Rept. [no. 1], 39 p., 3 illus., 8 maps, 2 charts, 2 diags., 2 tables, Sept. 1959, 37 refs.

This is the first of a series of reports on an expedition carried out in order to reconstruct the late Pleistocene environments of southern Chile and thereby uncover facts leading to an understanding of interhemispheric climatic relationships and the underlying mechanisms causing climatic changes. Recent variations in San Rafael and Del Rio Manso glaciers are inferred from historical, topographic, and biologic evidence. An attempt to study Fitz Roy glacier was made, but the expedition was unable to reach it.--M. Russell.

2-2823. Muller, Ernest H. GLACIAL GEOLOGY OF THE LAGUNA SAN RAFAEL AREA: Am. Geog. Soc., Southern Chile Exped., 1959, Tech. Rept. [no. 2], 23 p., 11 illus., 4 maps, 2 secs., table, Oct. 1959, 22 refs.

The second in a series of reports [first report, see above] on an expedition carried out in order to reconstruct the late Pleistocene environments of southern Chile. It reports on investigations made during Jan. and Feb. 1959.

Glaciation of the W. slope of the Andean cordillera was long and complex through the Pleistocene, but in the Laguna San Rafael area, late glaciation has effaced detailed evidence of preceding stages. The fact of previous glaciation is demonstrated by gross physiographic features, but its history must be studied in detail elsewhere.

Glacial features and deposits bordering Laguna San Rafael, except on the E. shore, date from a late episode of the last major Pleistocene glaciation, during which interval San Rafael existed as a massive expanded-foot glacier. Moraines representing this episode enclose the basin of Laguna San Rafael and are transected by high bluff exposures near the head of Rio Tempanos. Low moraine ridges and an extensive outwash plain, particularly well developed on the NE. shore of Laguna San Rafael, represent minor oscillations of San Rafael glacier during the much diminished expanded-foot phase of recent centuries.--From auth.

2-2824. Cook, Frank A. PERIGLACIAL-GEOMORPHOLOGICAL INVESTIGATIONS AT RESOLUTE, 1959: Arctic, v. 13, no. 2, p. 132-135, June 1960.

In the summer of 1959 the Geographical Branch, Dept. of Mines & Technical Surveys, Ottawa, instituted a long-term program of research into problems of periglacial geomorphology in the area of Resolute, Cornwallis Island, Northwest Territories. This preliminary report considers some aspects of the program in general terms. Among projects discussed are: frequency and amplitude of freeze-thaw cycles in the active layer, the run-off characteristics of the Mecham River, and precipitation as an erosive agent in a high arctic area.--Auth.

2-2825. Kachadoorian, Reuben, and others. SUPPLEMENTARY REPORT ON GEOLOGIC INVESTIGATIONS IN SUPPORT OF PHASE II, PROJECT CHARIOT IN THE VICINITY OF CAPE THOMPSON, NORTHWESTERN ALASKA: U.S. Geol. Survey, Trace Elements Inv. Rept. 764, 30 p., map, 5 diags., 2 tables, 1960, 4 refs.

Since 1958, the U.S. Geological Survey has conducted studies contributory to a project (Chariot) to produce, through nuclear explosions, an excavation at the mouth of Ogotoruk Creek, northwestern Alaska, as part of the U.S. Atomic Energy Commission's Operation Plowshare. This report presents geothermal and ground-water information obtained during the winter and spring of 1959-1960, and observations and conclusions from coastal processes studies. A brief geologic summary of the area is included. Winter coastal processes in the vicinity of Cape Thompson affect the beach material very little, except locally to disturb the sediments at a depth of about 6 ft. below sea level. The chief effect of the winter freezing is generally to arrest the coastal processes. Extrapolation of geothermal data from holes drilled to 598 ft. and 1,172 ft. indicates permafrost extends to from 1,000 to 1,200 ft. in the area and that permafrost is thicker and more extensive near the shoreline than would have been anticipated from equilibrium theory.--M. Russell.

The 3 papers making up this report are as follows: Preliminary Interpretation of Geothermal Data from Ogotoruk Creek, Alaska, by Arthur H. Lachenbruch; Observations of Coastal Processes in the Vicinity of Cape Thompson, Alaska, from May 3 to May 9, 1960, by George W. Moore; Winter Ground Water Investigations in the Vicinity of Cape Thompson, Alaska by Roger M. Waller.

2-2826. Kuenen, Philip H. EXPERIMENTAL ABRASION 4: EOLIAN ACTION: Jour. Geology, v. 68, no. 4, p. 427-449, 7 illus., chart, 10 diags., 8 tables, July 1960, 29 refs.

Abrasion by eolian transport was studied in 3 different types of wind tunnel. Limestone, feldspar, and quartz were tested in the shape of cubes, crushed crystals, or natural grains. Abrasion increases with size, wind velocity, angularity, and roughness of surface. Polished medium-sized quartz grains sustain no loss. Wind abrasion of quartz is 100 to 1,000 times more effective over the same distance than the mechanical action of a river. But eolian abrasion is slight for fine quartz sand and drops to zero at 0.05 mm. in diameter. No quartz particles are produced in the size range dominating in loess.

Experimental abrasion of ventifacts indicates that these are cut slowly in scores of years by medium strong winds, but in a matter of days by storm winds, and in a matter of hours if the cutting sand is coarse and angular. These results must be looked upon as first approximations, for many factors in nature are either unknown or not reproduced in the experiments. Experiments on frosting and defrosting will be treated elsewhere.--Auth.

2-2827. Bagnold, Ralph A. SOME ASPECTS OF THE SHAPE OF RIVER MEANDERS: U.S. Geol. Survey, Prof. Paper 282-E, p. 135-144, 10 diags., 1960, 6 refs.

From consideration of the probable nature of flow resistance in curved channels, a simple dynamical model is proposed to relate resistance to a criterion of bend curvature applicable both to closed pipes and to open channels. The theory indicates that resistance should fall to a minimum when the radius of channel curvature bears a certain critical ratio to the channel width; and this critical ratio should have approximately the same value for both closed and open channels, irrespective of scale or of boundary roughness.

Resistances of pipe bends are known to fall to a sharply defined minimum when the curvature ratio, mean radius to diameter, is between 2 and 3. Recently measured flow resistances of sinuous open channels disclose that the same minimum occurs at approximately the same curvature ratio.

The theory therefore appears to go some way in explaining the mechanism tending to restrict the bends of rivers of all sizes to a curvature ratio between 2 and 3.--Auth.

2-2828. Crickmay, C.H. LATERAL ACTIVITY IN A RIVER OF NORTHWESTERN CANADA: Jour. Geology, v. 68, no. 4, p. 377-391, 3 illus., 3 maps, July 1960, 8 refs.

The work reported has a background in several principles of fluvial hydraulics: the tendency to flow channels, the concentration of fluvial force against oncave banks, the mechanism of interdependence, e importance of approximate grade and its result, onvertical corrasion. An example of breaching by teral corrasion of a bedrock meander neck is described, and evidence from maps is brought forward o demonstrate horizontal bedrock erosion at a rate f 1 ft. a year. A rate of upstream knickpoint migration of 100 ft. a year is established from observation. A topographic form consisting of a slip-off slope with a prominence at its lower end is given the name "pembina" - the origin of which is traced to onvertical corrasion. The theoretical search for this origin is dependent on the hypothesis of unequal activity.--Auth.

2-2829. Broscoe, Andy J. QUANTITATIVE ANALYSIS OF LONGITUDINAL STREAM PROFILES OF SMALL WATERSHEDS: Columbia Univ., Dept. Geology, Tech. Rept. no. 18, 73 p., 2 geol. maps (in pocket), scale 1:24,000, 44 figs. incl. maps, profiles, diags., graphs, 9 tables, 1959, 75 refs.

Previous investigators used logarithmic, exponential, and power functions for equations of long stream profiles. Rational bases exist for the possible validity of all these forms.

To determine the applicability of these equations to low-order streams, 6 small areas were tested by map and field studies. Individual profiles in the Salt Run, Pennsylvania, area are not simple curves, but are segmented, each segment corresponding to a given order. Graphical and statistical tests show individual segments to be concave-up but not necessarily best-fitted by any one equation. A composite profile having mean properties of segments of successive orders appears to be best described by a logarithmic equation. The mean altitude change for any order segment appears to be a constant, independent of order.

In the Highlands Ranch, Colorado, area 2 generations of topography exist. The older, more subdued topography is characterized by a constant mean altitude difference in first- and second-order segments. The younger topography possesses steeper gradients and shows increase of altitude change with increasing order. Apparently the older topography is being destroyed by the younger. A constant mean altitude difference is considered typical of the steady state, but not of topography undergoing rapid rejuvenation. The small nickpoints present in the older topography may yield appreciable sediment to the drainage system. Individual segments are typically linear, with gradients decreasing at each increase in order. The Long Canyon, Colorado, area resembles the Highlands Ranch area in that segment profiles are typically almost linear, although the former area is higher, cooler in climate, and underlain by resistant rock.

The Manitou Park, Colorado, area has been so seriously affected by numerous stages of pedimentation and rejuvenation that the mean altitude changes very erratically with order. Apparently the rejuvenations have altered altitude changes without affecting segment lengths.

The Widow Woman Canyon, Colorado, area resembles the Salt Run area in that the mean altitude difference is a constant. Profiles are segmented, individual segments varying in form between a straight line and a concave-up curve.

The Chileno Canyon area is typified by a constant mean altitude difference. Profiles are segmented, individual segments being concave-up, like the Salt Run profiles. The composite profile is logarithmic.

Profile segmentation appears to be due to changes in the relationship between sediment load and discharge at a change in order. Gilbert's flume experiments indicate the general up-concavity of stream profiles results primarily from downstream increases in discharge. Linear segments may, however, be the natural stable forms of low-order stream profiles in dry climates. Horton's laws of stream length and stream slope are confirmed by the data gathered in this study.--Auth.

2-2830. Weber, Jon N. ONTARIO UNDERGROUND: Can. Geog. Jour., v. 61, no. 2, p. 42-51, 7 pls., 8 maps, Aug. 1960.

Ontario's caverns are small because the high Mg content of the limestone reduces solubility and because the carbonate beds themselves are relatively thin. Nevertheless, several caves exhibit curious calcite deposits and various forms of cavern life. The locations of the more important caverns are given along with some detailed plans.--J. A. Chamberlain.

2-2831. Halliday, William R., and Ellis Hedlund. THE CAVES OF FRESNO COUNTY, CALIFORNIA: Natl. Speleol. Soc., Western Speleol. Survey, Serial no. 16, 16 p., March 1960, approx. 35 refs.

The caves of Fresno County, California, are catalogued and described. Separate descriptions are given for the following caves: Bat, Bear, Beauty, Boyden, Church, Cliff, Converse Creek, Corkscrew, Ernest Smith, Hidden Pond, Hour Glass, Indian, Keyhole, Kings River, Saturday, Twin Lakes, Whale Rock, and Windy Cliff. A considerable number of caves open into the Kings Canyon walls. While some are quite small, Church Cave is California's deepest known cave, and the Church-Boyden system may be the most extensive in the state. The caves are in steeply tilted roof pendants of marble. The patterns displayed are generally of phreatic origin, but Boyden Cave may have been developed largely through invasion by flood waters.--M. Russell.

2-2832. McDonald, Howard. AN INITIAL REPORT ON OPHIR CAVE, MONTANA: Natl. Speleol. Soc., Western Speleol. Survey, Serial no. 15, 3 p., Apr. 1960, 2 refs.

An examination of Ophir Cave, Lewis and Clark County, Montana, fails to substantiate in any way an earlier published report that its depth is about 3,000 ft. Evidence of abandoned mining operations, odd speleothems, crawlways, and room dimensions is reported.--M. Russell.

2-2833. Parry, J.T. THE LIMESTONE PAVEMENTS OF NORTHWESTERN ENGLAND: Can. Geographer, no. 16, p. 14-21, 8 illus., map, 3 secs., 1960, 20 refs.

A brief review of the evolution of the limestone pavements in the NW. of England. They were formed in late glacial times as the result of snow bank solution, which probably continued until as late as the Pre-Boreal of Pollen Zone IV, about 7,500 B.C. The large grykes developed along the joint systems also date from this period. With the rapid amelioration and reduced precipitation of the Boreal and Atlantic periods leading to the "climatic optimum," solutional activity and gelivation were reduced in intensity, and the colonization of grasses continued fairly steadily.

The vegetation cover may have been more extensive during the "climatic optimum" than at present, and in some areas the pavements show signs of having carried a vegetation cover at some period prior to the present. The pavemented surfaces that remain in the present landscape owe their preservation in part to the warmer and dryer conditions with less solutional activity and considerably less gelivation, which existed from about 5,000 B.C. to the Roman period. At the present the pavements are in a process of fairly rapid decay, with the accumulation of debris on the surface and the formation of shallow grykes.--Auth.

2-2834. Giddens, J.E., and others. SOILS OF GEORGIA: Soil Sci., v. 89, no. 4, p. 229-238, 6 figs., table, Apr. 1960, 9 refs.

The 8 major soil provinces of Georgia are surveyed with relation to the underlying parent materials, topography, climate, and drainage. In general the red-yellow podzolic soils predominate because of the warm climate, but due to variations in drainage and topography, a total of 12 soil groups are delineated throughout the state. The relationship between the parent rock and the soil development in the different provinces is illustrated by cross sections of the bedrock structure and is amplified by descriptions of each soil group.--C. W. Schreiber.

2-2835. Bulavin, B.P. FOSSIL SOILS OF THE AZOV SEA COAST: Pochvovedeniye. Soviet Soil Sci., in translation, 1959, no. 1, p. 123-125, 2 illus., pub. Aug. 1960, 6 refs.

Numerous parallel horizons of humuslike clay loam in the loess formations around the sea of Azov are attributed to deposition by glacial meltwater all within a single glacial epoch.--M. Russell.

2-2836. King, Cuchlaine A.M. BEACHES AND COASTS: 403 p., maps, profiles, diags., graphs, tables, London, Edward Arnold; [New York, St. Martin's Press], 1959, refs.

Since D.W. Johnson's *Shore Processes and Shoreline Development* was published in 1919, much work has been done on the processes at work on the coast and on the evolution of different coastal areas. This book is an attempt to gather together some of the recent work on coastal problems, especially those associated with the character of the beach. It is hoped that the book may contain information of use to civil engineers and others engaged in research or planning in such areas.--From auth. pref.

The volume deals in turn with the following subjects: main factors on which the character of the beach depends (beach material, waves, tides, winds); methods of research; waves; movement of material on the beach; beach profiles - experimental results and surveying techniques; effect of wind; classification of beaches and coasts; constructive wave action and coastal accretion; destructive wave action and coastal erosion; beach gradient and beach profiles; historical data on coastal change; coastal types and their development - the marine cycle.

2-2837. McGill, John T., comp. SELECTED BIBLIOGRAPHY OF COASTAL GEOMORPHOLOGY OF THE WORLD: 50 p., The Author, University of California, Los Angeles, 1960.

The bibliography consists of 933 references, principally those used in preparation of a map of coastal landforms of the world (Geographical Review, v. 48, p. 402-405, 1958). Compilation was supported by the Geography Branch, U.S. Office of Naval Researc The bibliography is based mainly on materials found in libraries and map collections of the University of California. The grouping of regional references is based on a combination of the natural and political geographic distributions of the sea coasts of the world. Preference is given to maps at scales of 1:5,000,000 to 1:500,000. References dealing only with very limited coastal areas and with beaches are generally excluded. Antarctic coasts are not included because of generally incomplete coverage and poor reliability of existing reference materials.--From auth. pref.

The 2 parts consist of regional references and topical references. Major regions dealt with are: World (general); North Polar region; North and Central America (including Greenland); West Indies; South America; Atlantic Ocean and islands (including Iceland); Europe and eastern Mediterranean - Black Sea region; Asia; Arabian peninsula and Red Sea; Africa; Indian Ocean and islands; East Indies; Australia and Tasmania; Pacific Ocean and islands.

Topical subjects covered are: geomorphology; marine geology; photointerpretation; military geology; coastal engineering; Quaternary era; snow, ice, and permafrost.

2-2838. Putnam, William C., and others. NATURAL COASTAL ENVIRONMENTS OF THE WORLD: 140 p., 67 figs. incl. illus., diags., graphs, 3 maps (in pocket), 4 tables, The Author, University of California, Los Angeles, 1960.

This study was initiated in 1951 as a result of discussions with the Geography Branch, U.S. Office of Naval Research. It was recognized that there existe a genuine need for 1) a broad world-wide approach to the problem of coastal classification, and 2) the preparation of a workable guide to be used by photointerpreters in making terrain studies throughout the world. This handbook is styled for, and the emphasis is placed on, the aspects of coastal classification appropriate to the training and needs of photointerpreters and persons concerned with the preparation of terrain analyses. Although the information shown on the maps and discussed in the text necessarily deals in generalities, it is hoped that it will serve as a guide and provide a workable terminology and classification scheme for local, detailed studies as well.--From pref.

The handbook is in 3 parts. The first deals with coastal landforms of the world and covers coastal processes and terminology, landforms of coastal areas, constructional landforms (alluvial plains, delta plains, ice plains and plateaus, ice deposition plains, dune plains and hills, coral plains and plateaus, volcanic plains, lava plateaus and volcanoes) and destructional landforms (plains coasts, plateau coasts, coastal hills, coastal mountains, selected shore features associated with major coastal landforms, etc.). The second and third parts cover coastal vegetation of the world and climates of coastal regions. The text is supplemented by many air photos of coasts in various parts of the world.

2-2839. Tanner, William F. EXPANDING SHOAL IN AREAS OF WAVE REFRACTION: Science, v. 13 no. 3433, p. 1012-1013, map, Oct. 14, 1960, ref.

Shoals and spits may grow seaward, despite powerful refracted wave attack, where the wave energy level is too low to handle the supply of sand introduced by the littoral drift. Spits and shoals of this type have distinctive shapes. They may support ripple marks which do not parallel the crests of the waves which form them.--Auth.

2-2840. Wood, Harold A. **WAVE TRANSPORT OF BEACH MATERIALS ON LONG POINT, LAKE ERIE:** Can. Geographer, no. 16, p. 27-35, 2 maps, 3 diags., 3 graphs, 4 tables, 1960, 6 refs.

Wave energy, the most significant factor in effecting shoreline change, can be evaluated from point to point along a shore using information obtained from wind records and hydrographic charts. Under favorable circumstances, it is also possible to ascertain the amount of material being transported in a given period of time by a given amount of energy expended parallel to the shore.

On Long Point [Ontario] the rate of shoreline change is correlated with the amount of material being added or removed by lateral wave transport, as well as with the downshore variation in volume of the offshore part of the spit. However, most parts of the shore are retrogressing due to large annual removals of material seaward.

Although it is beyond the scope of this paper to do so, the relationships discovered will permit a prediction of future changes on the shore of Long Point. For example, even a cursory examination indicates that the next breakthrough by waves across the spit will occur in the vicinity of reference point 1 and in about 200 years. It would appear likely, moreover, that the results of the study might well be applicable to other sand spits as well, provided the materials of which they are composed are similar to those of Long Point.

Finally, in pursuing a study of this type, one is struck by the limitless possibilities for further refinement in the method employed. This should not be taken as the final word on the subject, but simply as the result of one stage in the search for a more complete understanding of beach morphology.--Auth.

2-2841. Tuttle, Sherwood D. **EVOLUTION OF THE NEW HAMPSHIRE SHORE LINE:** Geol. Soc. America, Bull., v. 71, no. 8, p. 1211-1222, map, 3 tables, Aug. 1960, 30 refs.

The encroaching sea came against glacially eroded bedrock and several types of glacial and glaciomarine deposits in New Hampshire. Wave action, concentrating on till headlands and rock promontories, has built a variety of beach types. Detritus has been drifted locally in both directions along the shore, and the longshore drifting has no over-all pattern. The beach trends are not parallel to the general shoreline trend, and the writer suggests that individual beaches are oriented normal to the largest storm waves that reach the area. Following deglaciation, the land has risen isostatically and the sea level eustatically. Evidence indicates that a postglacial sequence of relative submergence, emergence, and submergence has occurred. Classical geomorphic shoreline classifications do not fit every part of the area, and it is therefore best described geographically and in terms of its evolution. --Auth.

2-2842. Emery, K.O. **BASIN PLAINS AND APRONS OFF SOUTHERN CALIFORNIA:** Jour. Geology, v. 68, no. 4, p. 464-479, 12 maps, profile, diag., July 1960, 25 refs.

Precision echo soundings made across the submarine basins off southern California show that parts of their floors are remarkably smooth and horizontal. Fringing these flat areas are larger areas which have gentle slopes and extend to the basin sides. Where submarine canyons reach from near the shore to the basins, the upper parts of the gently sloping plains take the form of subsea fans. Physiographic and sedimentary evidence indicate that turbidity currents flow from the canyon mouths and deposit most of their loads of sediment on the subsea fans and on the aprons beyond them. Thus the subsea fans are akin to alluvial fans on land. Only a small amount of sediment from turbidity currents reaches the nearly horizontal basin plains and the far sides of the basins. As the basins become filled with sediments from turbidity currents, from suspension in the whole water column, and from marginal mass-movements, the sediments spill from basin to basin in a manner analogous to the prograding of alluvial deposits in the block-faulted desert region of the western United States.--Auth.

2-2843. Bird, J. Brian. **THE SCENERY OF CENTRAL AND SOUTHERN ARCTIC CANADA:** Can. Geographer, no. 15, p. 1-11, 12 illus., 1960, ref.

This review of the state of geomorphology in arctic Canada is the presidential address delivered at the Ninth Annual Meeting of the Canadian Association of Geographers, Saskatoon, Saskatchewan, 1959. It summarizes the present knowledge of the evolution of northern scenery. Some of the most urgent problems are mentioned. Primarily, detailed studies of all phases of landscape evolution in as many areas as possible are required, with particular emphasis on the periglacial geomorphic processes.--F. A. Cook.

2-2844. Brown, A. Southerland. **PHYSIOGRAPHY OF THE QUEEN CHARLOTTE ISLANDS:** Can. Geog. Jour., v. 61, no. 1, p. 30-37, 8 pls., 4 maps, table, July 1960.

The position of the islands on the edge of the continental shelf makes them among the most interesting and perplexing areas of Canada. The islands are divided into 3 regions of differing topography which correspond fairly closely with belts of differing geology. Faulting has been active during Tertiary time. Current seismic records show that the islands are by far the most active earthquake area in Canada and that they are bordered on the W. by the Denali fault, a structure analogous to the San Andreas fault system of California.--J. A. Chamberlain.

2-2845. Robitaille, Benoît. **PRÉSENTATION D'UNE CARTE GÉOMORPHOLOGIQUE DE LA RÉGION DE MOULD BAY, ÎLE DU PRINCE-PATRICK, TERRITOIRES DU NORD-OUEST [PRESENTATION OF A GEOMORPHIC MAP OF THE MOULD BAY AREA, PRINCE PATRICK ISLAND, NORTHWEST TERRITORIES]:** Can. Geographer, no. 15, p. 39-43, fold. map, scale approx. 1:72,000, 1960, 6 refs.; text in French, abs. in French and English.

This map, constructed from field data and from information collected from aerial photographs, relates to an area of some 400 sq. mi. Superficial deposits have been mapped by the use of patterns and landforms by symbols. The text includes a description of the mapping technique and of the potential uses of this type of map for pure as well as for applied geomorphology.--Auth.

3. STRUCTURAL GEOLOGY

See also: Geomorphology 2-2844; Geophysics 2-2950, 2-2965, 2-2970, 2-2971; Mineralogy 2-3028.

2-2846. Volarovich, M.P., and others. STUDY OF THE COMPRESSIBILITY OF IGNEOUS ROCKS AT PRESSURES UP TO 5000 KG/CM^2: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 5, p. 486-492, 4 diags., table, pub. June 1960, 15 refs.

This paper describes the apparatus and laboratory methods. It gives the results of isothermal linear compressibility measurements on specimens of some igneous rocks. From the linear compressibility data are computed the isothermal volumetric compressibility, the isothermal modulus of volumetric compression, and the density of the investigated rocks within the pressure range mentioned above. A discussion of the experimental results is included.--Auth.

2-2847. Beloussov, V.V. TECTONOPHYSICAL INVESTIGATIONS: Geol. Soc. America, Bull., v. 71, no. 8, p. 1255-1269, 4 illus. on 2 pls., 9 figs. incl. profile, diags., secs., Aug. 1960, 50 refs.

The criteria of physical conformity elaborated in application to tectonic experimentation by M. King Hubbert, B. L. Shneerson, E. N. Lyustikh, and more fully by M. V. Gzovsky place tectonic experimentation on a solid methodological basis and show that it is entirely possible to attain a good approximation to physical conformity.

Tectonic modeling is an essential supplement to the geological methods of field structural research. An aptly applied experimental method enables one to detect very important aspects which ordinarily escape the geologist as they are being produced.

Soviet tectonophysical studies aim at studying fields of stress which acted in the earth's crust in earlier geological periods and the elaboration of appropriate techniques, one of which is the optical method of studying stressed states on models. Some results of recent investigations in tectonophysics are described.--Auth.

2-2848. Gzovsky, M.V., and others. QUANTITATIVE GEOLOGICAL CHARACTERIZATION OF THE MEAN GRADIENT OF THE RATE OF VERTICAL TECTONIC MOVEMENTS (DIP CHANGES) IN THE CONTINENTAL CRUST AND SOME RESULTS OF ITS APPLICATION: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 820-828, 7 figs. incl. maps, diags., graphs, 2 tables, pub. July 1960, 13 refs.

Geological methods enable us to observe dip changes on the surface as well as at various levels within the sedimentary cover of the crust over extended periods of time (thousands to tens of millions of years). It is possible to compute for these time intervals the mean gradients of the rate of vertical tectonic movements in the crust $(\mathrm{grad}\ V)_m$, equal to the average rate of changes in dip V_φ. Stratigraphic, structural, and geomorphological methods are outlined for these calculations.

2-2849. Hess, H.H. THE AMSOC HOLE TO THE EARTH'S MANTLE: Am. Scientist, v. 48, no. 2, p. 254-263, 5 figs. incl. graphs, June 1960, 10 refs.

Theories, meteorites, and geophysical studies provide only an incomplete knowledge of the composition of the earth's mantle. A drillhole to the Mohorovičić discontinuity, or Moho, has been proposed, and selection of a site is currently under way. By drilling from a barge on the deep seas the Moho can be reached at 30,000 to 35,000 ft. depth, only half of which need be drilled. From samples the physical properties, age, composition and mineral phases, isotope content, and radioactivity of the mantle could be determined. More detailed data would at last be available regarding the section from the ocean's floor to the mantle.

Based upon present knowledge the author predicts drilling will reveal the following column, from the ocean floor downward: 1) unconsolidated sediments; 2) consolidated sediments, with or without volcanic material; 3) sepentinized peridotite; and 4) a peridotitic mantle.--T.H.W. Loomis.

2-2850. Wheeler, John O. MESOZOIC TECTONICS OF CENTRAL SOUTHERN YUKON: Geol. Assoc. Canada, Proc., v. 11, p. 23-43, 2 maps, sec., chart, 2 diags., Dec. 1959, 51 refs.

The Whitehorse trough was established in the late Triassic in central southern Yukon and northwestern British Columbia along a zone the flanks of which, at least, had been subjected to uplift, folding, and some volcanism following a period of tectonic quiet near the end of the Permian. This trough lay E. of a volcanic island arc that probably extended along what is now the axis of the Coast Mountains. Near the end of the Triassic, the volcanic arc became inactive, until, in early Jurassic time, parts of the arc were uplifted at irregular intervals to form a tectonic land from which coarse sediments poured into the trough to the E. Some sediment was also derived from land E. of the trough. Just before or during this period of uplift, granitic bodies of calc-alkaline types were exposed to erosion within the volcanic rocks of the island arc. These bodies were either intrusions or upfaulted parts of older terrains. In late Jurassic and early Cretaceous time the trough was segmented so that in central southern Yukon it formed a more or less enclosed basin receiving siliceous clastic sediments from the core of the considerably eroded tectonic land to the W. and possibly from another siliceous terrain to the E. In middle Cretaceous time the life of the trough came to an end, and the rocks in it were deformed into a synclinorium later disrupted by the Atlin horst. Ultramafic rocks, possibly intruded in the Permian, may have been displaced upward at this time. The folded rocks were partly eroded and then overlain unconformably by volcanic rocks. Finally the whole assemblage was intruded by granitic bodies.

Although the late Triassic history of the Whitehorse trough was eugeosynclinal, its later history shows that this trough had characteristics in common with the idiogeosynclines of the East Indies, with the western Californian geosynclines younger than the Nevadan orogeny, and with epieugeosynclines.--Auth.

2-2851. Fetzner, Richard W. PENNSYLVANIAN PALEOTECTONICS OF COLORADO PLATEAU: Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 8, p. 1371-1413, 15 maps, chart, Aug. 1960, 48 refs.

During the Pennsylvanian interval of time, the Colorado Plateau area underwent the most active period of tectonic activity of the Paleozoic era. Pennsylvanian paleotectonic relationships have been reconstructed from stratigraphic and lithologic data acquired from 264 control points. This was accomplished through the use of isopach maps, lithologic ratio maps, vertical sandstone distribution maps, field evidence, and paleontological data.

Pennsylvanian tectonic elements of the Colorado Plateau area defined a NW.-trending parageosynclinal seaway. Greatest subsidence occurred in the N. where the Paradox salt basin formed as an asymmetrical half graben. On the S., depositional centers formed in the Pennsylvanian San Juan and Lucero basins. The seaway opened NW. onto the rapidly subsiding Oquirrh shelf, NE. into the northern Colorado trough, W. into the Cordilleran geosyncline, SE. into the southern Colorado trough, and S. and SW. into the Pedregosa basin and the Sonoran geosyncline. The seaway was bounded to the NW. by the Emery uplift, to the NE. and E. by the Uncompahgre and San Luis uplifts, and to the W. and SW. by the Kaibab-Zuni uplift. The Defiance uplift, a structural subsidiary of the Kaibab-Zuni lineament, projected N. into the southern Paradox basin, where it strongly affected depositional patterns during Pennsylvanian time.

Throughout most of Pennsylvanian time, the Emery uplift was a low, partly submerged, structural arch. A southeastern spur of tectonism, probably archipelagic in nature, affected depositional patterns from Des Moines to Wolfcamp time in the northwestern Paradox basin. Earliest and greatest Uncompahgre tectonism occurred in its southern part. Here it became a clastic source area in Atoka time, remained orogenically positive into the Permian, and during this time interval shed a tremendous coarse clastic delta to the SW. The northwestern Uncompahgre responded to uplift later in the Pennsylvanian, but probably permitted marine access between the Eagle and Paradox evaporite basins during Des Moines time. Consequently, Paradox evaporites may be the composite product of 2 evaporite basins. The San Luis uplift, which was slightly positive in pre-Pennsylvanian time, did not respond to sharp uplift until late Pennsylvanian time. The Penasco uplift underwent early and late Pennsylvanian tectonism, but impressed only minor influence on the regional lithofacies. Although the Kaibab-Zuni uplift existed as a nearly continuous structural lineament during most of the Pennsylvanian, greatest and earliest tectonism occurred in the eastern, or Zuni segment. The Defiance uplift was probably positive in the Mississippian, and underwent successive tectonic pulses during Atoka-early Des Moines, late Des Moines, and late Pennsylvanian-early Permian times. Major hydrocarbon production in the Four Corners area [Colorado, New Mexico, Arizona, and Utah] displays close relationship to this tectonic element geographically and geologically.

Because of sedimentary and tectonic barriers, a thick sequence of evaporites was deposited within the Paradox salt basin. The Emery and Uncompahgre uplifts created restriction on the NW., N., and E., and the Kaibab-Zuni uplift provided restriction on the SW. The combination of a clastic barrier projecting into the Four Corners area from the NE. and the Defiance uplift projecting into Four Corners area from the SW. formed nearly continuous physical restriction across the southern Paradox basin and provided conditions necessary for cyclical evaporite deposition within the basin.--Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Geologic Maps 2-2776; Areal and Regional Geology 2-2811; Geomorphology 2-2820, 2-2821; Structural Geology 2-2851; Paleontology 2-2881, 2-2883, 2-2891, 2-2893, 2-2909, 2-2912, 2-2921, 2-2925, 2-2928, 2-2930, 2-2931, 2-2933, 2-2934; Geophysics 2-2952; Mineralogy 2-3022; Igneous and Metamorphic Petrology 2-3040; Sedimentary Petrology 2-3045, 2-3051, 2-3052, 2-3053, 2-3056, 2-3057, 2-3060; Geohydrology 2-3065; Mineral Deposits 2-3085, 2-3098, 2-3101; Fuels 2-3115.

2-2852. Lankford, Robert R., and Francis P. Shepard. **FACIES INTERPRETATIONS IN MISSISSIPPI DELTA BORINGS:** Jour. Geology, v. 68, no. 4, p. 408-426, illus., map, secs., 6 charts, table, July 1960, 12 refs.

A study has been made of samples cut from borings drilled by the U.S. Army Corps of Engineers between New Orleans and the Chandeleur Islands and extending to depths of 60 to 180 ft. in the now-abandoned St. Bernard subdelta of the Mississippi River. Interpretations of depositional facies are based on criteria obtained in the study of modern deltaic sediments in and around the presently forming birdfoot delta. The Foraminifera were particularly useful as environmental indicators, but grain-size and coarse-fraction analyses also were diagnostic in many places.

It was possible to correlate many of the facies between borings. The resulting section shows the transgression of Holocene (Recent) marine sediments over an eroded Pleistocene delta. During this initial marine encroachment there was deposition of relatively thin shelf sands containing abundant shells and Foraminifera. Later the Mississippi River shifted its locus of deposition, and the St. Bernard subdelta prograded across the shallow shelf. During this stage the rate of deltaic sedimentation was greater than the rate of rise of post-Pleistocene sea level, resulting in an apparent regressive facies formed during a eustatic transgression. Subsidence of the subdelta and its abandonment by the Mississippi River have permitted the sea to attack and rework the seaward portions with the attendant formation of discontinuous barrier islands and shallow-water sound deposits.--Auth.

2-2853. Clark, Thomas H. **STRATIGRAPHY OF THE TRENTON GROUP, ST. LAWRENCE LOWLAND, QUEBEC:** Geol. Assoc. Canada, Proc., v. 11, p. 13-21, map, Dec. 1959, 14 refs.

The historical development of the stratigraphy of the Middle Ordovician Trenton group is reviewed. The standard sequences of Ontario and New York cannot be recognized as such in the Quebec lowland but the following correlations are proposed:

	Ontario	Montreal	Grondines-Neuville
TRENTON GROUP	Cobourg	Tetreauville incl. Terrebonne	Neuville
	Sherman Fall	Montreal	
	Hull	Deschambault	St. Casimir
			Deschambault
	Rockland	Ouareau	Fontaine-St. Alban-Pont Rouge

From observations of changes in lithology and thickness of rock units it is concluded that a hinge line between an area of shelf deposition to the NW. and a miogeosyncline to the SE. runs approximately along the curve of the present St. Lawrence River. --M. Russell.

2-2854. Marleau, Raymond A. AGE RELATIONS IN THE LAKE MEGANTIC RANGE, SOUTHERN QUEBEC: Geol. Assoc. Canada, Proc., v. 11, p. 129-139, map, Dec. 1959, 22 refs.

The Lake Megantic range is a continuation of the White Mountains of the Appalachian Uplands. Its rocks can be divided into 5 parallel mappable units that can be grouped into 3 separate formations: Frontenac formation (volcanic rocks, sedimentary rocks), Compton-Seboomook formation (Compton slate, Seboomook slate), Arnold River formation (crystalline metasandstone). Plutonic rocks occur abundantly in the southern part of the range.

A new interpretation of the stratigraphic sequence is proposed. The rocks previously assigned to the Precambrian can be traced into similar rocks in Maine, where they have been dated as Silurian and Lower Devonian on fossil evidence.

The Lake Megantic sequence is tightly folded. New data on the structure of the rocks show that the "Boundary Hills anticline" or "Lake Megantic anticline" is actually a broad syncline. The latter is considered a part of the Gaspé-Connecticut River synclinorium, which is interpreted as having been an orthogeosynclinal basin of post-Taconic rocks.--Auth.

2-2855. Kottlowski, Frank E. SUMMARY OF PENNSYLVANIAN SECTIONS IN SOUTHWESTERN NEW MEXICO AND SOUTHEASTERN ARIZONA: New Mexico, Bur. Mines & Mineral Resources, Bull. 66, 187 p., 13 pls., 34 figs., 2 tables, 1960, 158 refs.

The Pennsylvanian strata range from Morrowan(?) to Virgilian in age, are disconformable to angularly unconformable above Precambrian to Upper Mississippian rocks, and are as much as 4,000 ft. thick, although in most localities they range from 1,000 to 2,000 ft. in thickness. The Pennsylvanian-Permian contact in many areas appears to be gradational, and the boundary is drawn within a zone of indeterminate age between Virgilian and Wolfcampian fossil-bearing beds. Permian rocks at some localities, as well as Cretaceous and Tertiary rocks in other places, are erosionally unconformable on the Pennsylvanian strata. In the southern Hueco Mountains and the Florida Mountains areas, all the Pennsylvanian beds apparently were removed by erosion during early Permian time.

Clastic sediments were derived chiefly from the Pennsylvanian-age Pedernal Mountains to the E., and locally from the Florida, Joyita, Zuni-Defiance, and Kaibab positive-tending areas, which at times during the Pennsylvanian were emergent and during other epochs were covered by shallow seas. Five basinal downwarps, where thick sections were deposited, stand out on the isopach maps: 1) Estancia trough, 2) Orogrande basin, 3) Pedregosa basin, 4) Lucero basin, and 5) San Mateo basin. The Orogrande, San Mateo, and Lucero basins are aligned along a N.-S. trend that probably marks a channelway northward across the Cabezon sag to the Paradox basin; the Pedregosa and Orogrande basins probably connected eastward with the Marfa and Delaware basins. Over a large area from Clifton, Arizona, southeastward to the Florida Mountains in New Mexico, Pennsylvanian rocks are absent, and Permian or Cretaceous strata rest on pre-Pennsylvanian rocks.

Pennsylvanian strata are potential sources of oil and gas at least in the northern and eastern parts of the region, on the southern edge of the Colorado Plateau, and in the Estancia Valley, Acoma embayment, Chupadera Mesa, Jornada del Muerto, and the Tularosa Valley. Even the basin-and-range country and the Datil-Mogollon volcanic plateau are underlain by possibly productive Pennsylvanian (and Permian) beds. Large-scale use of the various Pennsylvanian rocks as industrial minerals and rocks is hampered by the long distances to populous areas, the limestones, shale, and gypsum having been used only locally for building stone and crushed rock, in agriculture, and to make bricks, tile, cement, and lime products.--Auth.

2-2856. Moberly, Ralph M., Jr. MORRISON, CLOVERLY, AND SYKES MOUNTAIN FORMATIONS NORTHERN BIGHORN BASIN, WYOMING AND MONTANA: Geol. Soc. America, Bull., v. 71, no. 8, p. 1137-1176, 15 illus., 4 maps, 3 charts, 5 secs. (1 fold.), 2 diags., table, Aug. 1960, 83 refs.

The Morrison, Cloverly, and Sykes Mountain formations are the uppermost Jurassic and lowermost Cretaceous sedimentary rocks in the northern Bighorn basin, Wyoming and Montana. Similar formations were deposited contemporaneously throughout most of the western interior.

Most studies of nonmarine rocks have been in localities of more rapid sedimentation, whereas the rocks of this study accumulated slowly, under virtually atectonic conditions.

The Morrison formation of the Bighorn basin, as here restricted, includes the earliest-formed nonmarine sedimentary rocks of this sequence, conformably overlying the marine Sundance formation. The rocks are interlensed calcareous quartz sandstones, green mudstones and shales, and subordinate limestones, with locally conspicuous red-banded mudstones.

Overlying the Morrison formation, generally with conformity, is the Cloverly formation, as redefined in this report. The lowest of its 3 members, here named the Little Sheep mudstone members, consists chiefly of bentonitic (montmorillonitic) mudstones in variegated shades of neutral gray, purple, olive, and dusky to pale red. Other typical lithologies include bentonites, cherts, coaly beds, calcareous nodules, and chert-pebble conglomeratic sandstones. The Pryor conglomerate member in the northernmost Bighorn basin is characterized by black-chert pebbles and rests unconformably on the Morrison formation. Its beds are the stratigraphic equivalent of the mid-Little Sheep conglomeratic sandstones farther S. The upper member of the Cloverly formation, here named the Himes member, comprises 3 principal lithologies. Commonly at its base is olive-gray and reddish-brown clay-matrixed salt-and-pepper sandstone. Most of the member is variegated reddish- and yellowish-brown and gray kaolinitic claystone and mudstone, containing veinlets and hardpans of iron oxides. Clean quartz sandstones which filled fluvial channels are laced through the claystones.

Disconformably overlying the Himes member are sandstones and thinly interbedded, rusty-brown-weathering siltstones, dark shales, and ironstones, here named the Sykes Mountain formation. The

Sykes Mountain formation grades into the overlying marine Thermopolis shale.

Distinction of stratigraphic units on a lithogenetic basis is believed to eliminate the confusion which existed in previous nomenclature of this sequence.

Characteristic primary and secondary structures, clay, accessory, and authigenic minerals, and gross stratigraphic distribution aided the interpretation of the origin and history of these deposits. The Morrison formation accumulated in fluvial, lacustrine, and flood-plain environments from detritus derived chiefly from erosion of sedimentary rocks W. of the present Bighorn basin. The Little Sheep mudstone member and most of the Himes member of the Cloverly formation probably were formed authigenically in seasonal lakes and swamps from weathering of volcanic debris, with their different lithologies due to different drainage conditions and parent ash. The Pryor conglomerate member of the Cloverly formation and lenses of similar conglomeratic sandstones in the Little Sheep member were derived from reworked sedimentary rocks W. of the depositional area. Channel-filling clean quartz sandstones of the Himes member were derived from an eastern sedimentary, and perhaps metamorphic, terrain. Thinly interbedded sandstones and shales of the Sykes Mountain formation are tidal-flat and other shallow-water beds deposited at the periphery of the transgressing Early Cretaceous sea.

Slow deposition of these well-sorted and mature detrital sediments and close adjustment of authigenic minerals to prevailing environments depended largely on the stable tectonic conditions. During Cloverly time, very little aggradation except of volcanic debris took place, so that soils were formed and preserved. --Auth.

2-2857. Regnier, Jerome. CENOZOIC GEOLOGY IN THE VICINITY OF CARLIN, NEVADA: Geol. Soc. America, Bull., v. 71, no. 8, p. 1189-1210, 4 illus., fold. map, 3 profiles, table, Aug. 1960, 36 refs.

The Cenozoic section in the vicinity of Carlin, northeastern Nevada, comprises the following units, separated by erosional or slight angular unconformities: 1) several thousand feet of volcanic rocks ranging from rhyolite to basalt; diorite and granodiorite intrusive rocks (early Tertiary?); 2) Rand Ranch formation (new name): 1,700 ft. of Paleozoic-pebble conglomerate and sandstone (Oligocene?); 3) Safford Canyon formation (new name): 700 ft. of volcanic conglomerate and sandstone, rhyolitic tuff, and limestone (late Oligocene, early Miocene?); 4) Raine Ranch formation (new name): 2,000 ft. of pumice lapilli tuff, volcanic breccia, lava flows, conglomerate, rhyolitic tuff, diatomite, shale, and limestone (late Miocene); 5) 500 ft. of rhyolite; 6) Carlin formation (new name): at least 600 ft. of tuffaceous conglomerate and sandstone, rhyolitic and basaltic tuffs, diatomite, shale, and limestone (early Pliocene); 7) Hay Ranch formation (new name): several thousand feet of lacustrine clay, limestone, and rhyolitic ash with basin-border facies of conglomerate and fanglomerates (middle Pliocene-middle Pleistocene); 8) thin welded tuff (Pleistocene). Units 4, 6, and 7 are dated by vertebrate fossils.

Basin and Range faulting was active from late Miocene to Pleistocene and may have begun in Oligocene time.

Rhyolitic tuffs are extensively altered to zeolites. The transformation seems to have taken place under the influence of the water of the lakes in which the volcanic glass was deposited. --Auth.

2-2858. Terasmae, Jaan. CONTRIBUTIONS TO CANADIAN PALYNOLOGY NO. 2: Canada, Geol. Survey, Bull. 56, 41 p., 6 illus, map, 3 secs., 16 pollen diagrams (3 in pocket), 3 tables, 1960, 36 refs.

Pt. 1. A Palynological Study of Post-Glacial Deposits in the St. Lawrence Lowlands. After the retreat of the ice, lacustrine conditions prevailed over the part of the St. Lawrence Lowlands between Montreal and Quebec City. This was followed by the marine inundation known as the Champlain Sea.

Over much of the area occupied by the Champlain Sea, bogs were subsequently developed, and a study of the pollen content of those bogs has led to the recognition of 6 pollen zones. The oldest of these started to form some 9,000 years ago when the sea stood at about the position of the present 250-ft. contour, 200 ft. or so below its maximum.

Although marine fossils are largely absent in deposits below this level, the pollen content of the bogs shows that they started to form in an orderly sequence from higher to lower levels. Thus, by means of palynological studies, terraces on either side of the river may be correlated.

Pt. 2. A Palynological Study of Pleistocene Interglacial Beds at Toronto, Ontario. Interglacial sands, silts, and clays are exposed in the Don Valley brickyard and the Scarborough Bluffs along the shore of Lake Ontario at Toronto. The basal beds consist of York till separated by a time interval from the overlying nonglacial beds. These are subdivided into the Don beds at the base and the Scarborough beds above, which are separated from each other by a hiatus and possibly a short glacial episode. The glacial beds above this are subdivided into the Sunnybrook till, the Danforth beds, and the Thorncliffe beds, in ascending order.

Palynological and paleontological studies show that Don beds were laid down when the annual mean temperature was warmer by some 5°F. than now, and the Scarborough beds when it was some 10° colder.

The Don beds were certainly deposited during an interglacial period, possibly to be correlated with the Sangamon. The Scarborough beds are tentatively assigned to the St. Pierre interval and may have formed during a substage in the onset of the Wisconsin stage proper.--Auth.

2-2859. Brinkmann, Roland. GEOLOGIC EVOLUTION OF EUROPE. Translated from the German by John E. Sanders: 161 p., 19 pls., 46 figs: incl. illus., maps, 18 correlation charts, Stuttgart, Ferdinand Enke; New York, Hafner, 1960, refs.

A condensed version of the second volume of the 8th edition of Abriss der Geologie. The 2-volume work covers both physical and historical geology; only those parts dealing with Europe have been included here to make an introduction to the geology of the area for English-speaking geologists. The translator has made some changes because of the different stratigraphic terminology used in Europe and North America. He has also added remarks concerning Sedgwick and Murchison's work in the SW. of England which led to the founding of the Devonian system, on Lyell's subdivisions of the Tertiary, and on Ewing and Donn's theory of the origin of Pleistocene climatic variations.--From translator's pref.

The 14 chapters cover the following: history of European geology; Precambrian; Cambrian; Ordovician; Silurian (Gotlandian); Devonian; Carboniferous; Permian; Triassic; Jurassic; Cretaceous; Tertiary; Quaternary; development of the European continent.

2-2860. Mason, Ronald J. **EARLY MAN AND THE AGE OF THE CHAMPLAIN SEA:** Jour. Geology, v. 68, no. 4, p. 366-376, map, July 1960, 36 refs.

Various dating techniques have yielded an approximately synchronous absolute chronology for fluted points characteristic of one phase of the Early Man or Paleo-Indian horizon in southern New England, the Upper Great Lakes, the high plains, and the southwestern United States. On the basis of these chronologies and on typology, some archeologists believe that closely similar artifacts elsewhere should be of nearly the same age. A recent attempt at geologically dating fluted points in areas formerly occupied by Lake Iroquois and the Champlain Sea has suggested, on the contrary, that this archeological assumption is incorrect and that the northeastern Paleo-Indian artifacts are not nearly as old as their counterparts elsewhere. The following paper examines this thesis and concludes with a reinterpretation of the geologic sequence in the Ontario basin and St. Lawrence Valley that seems to be supported by radiocarbon and by the most recent geological investigations involved, and that, if correct, removes the archeological enigma. It is suggested that the available radiocarbon dates for the Champlain Sea are substantially correct, that Lake Iroquois is older than heretofore thought, and that the reinterpretation is more compatible with archeological sequences outside the area discussed.--Auth.

2-2861. Lowdon, J.A., comp. **AGE DETERMINATIONS BY THE GEOLOGICAL SURVEY OF CANADA. REPORT 1 - ISOTOPIC AGES:** Canada, Geol. Survey, Paper 60-17, 51 p., 2 tables, 1960, 5 refs.

This publication is the first of a proposed series of annual releases of geological age determinations carried out in the laboratories of the Geological Survey of Canada. It includes all K-Ar age measurements completed to Dec. 31, 1959. In Pt. 1 are listed all pertinent experimental data as well as reference to the geological setting and brief remarks by the geologist responsible for field selection and interpretation. Determinations are listed from British Columbia, Yukon Territory, Northwest Territories, Saskatchewan, Manitoba, Ontario, Quebec, Nova Scotia, and Newfoundland. In Pt. 2 are more detailed discussions of the significance and application of age measurements to specific geological problems. The 2 papers included in this part are: Note on the Interpretation of the U-Pb, Th-Pb and K-Ar Ages in the Bancroft, Ontario, Region, by S.C. Robinson; K-Ar Dating in Keewatin and Eastern Mackenzie Districts, Northwest Territories.--A.C. Sangree.

2-2862. Fairbairn, H.W., William H. Pinson, Patrick M. Hurley, and R.F. Cormier. **A COMPARISON OF THE AGES OF COEXISTING BIOTITE AND MUSCOVITE IN SOME PALEOZOIC GRANITE ROCKS:** Geochim. et Cosmochim. Acta, v. 19, no. 1, p. 7-9 table, March 1960, 3 refs.

Comparison between the Rb-Sr ages of 11 mica pairs showed general agreement within the precision of the individual determinations, and agreement with K/Ar ages from the biotites. With one exception, therefore, the muscovite and biotite from the rocks studied are assumed to be cogenic. The rocks themselves, however, may have ages different from those determined from the micas.--F. Manheim.

2-2863. Blackadar, Robert G. **THE AGE OF THE METAMORPHIC COMPLEX OF NORTHERNMOST ELLESMERE ISLAND:** Arctic, v. 13, no. 1, p. 51-52, March 1960, 11 refs.

In 1953 the writer mapped a group of migmatites and gneisses between Cape Aldrich and Markham Inlet and named them the Cape Columbia group. R.L. Christie continued the mapping in 1954 and extended the group to include all rocks of advanced metamorphic grade. A specimen of biotite-rich gneiss was submitted for age determination by the K-Ar method which gave an age of 545 million years. It appears probable that the last metamorphism undergone by Cape Columbia group rocks occurred in lowermost Paleozoic or uppermost Precambrian time. The rocks themselves may be much older as the method dates only the most recent metamorphism. The existence of metamorphosed strata in northern Ellesmere Island suggests orogenic forces, and the resulting landmass may have been the source of the clastic sediments noted in the Parry Islands and Ellesmere Island.--A.C. Sangree.

2-2864. Fairbairn, H.W., and others. **AGE INVESTIGATION OF SYENITES FROM COLDWELL, ONTARIO:** Geol. Assoc. Canada, Proc., v. 11, p. 141-144, table, Dec. 1959, 5 refs.

The age of the syenite body at Coldwell on the N. shore of Lake Superior has been investigated by A/K and Sr/Rb mass spectrometric analysis of biotite and K feldspar concentrated from selected samples. For biotite in nepheline syenite, the preferred estimate of the A/K age is 1,065 million years and for the Sr/Rb age is 1,070 m.y. For K feldspar in augite syenite the preferred estimate of the age is 1,225 m.y. Although the significance of the discrepancy in the biotite and feldspar ages cannot be evaluated at present, the investigation nevertheless demonstrates the late Precambrian origin of the syenite in an environment of granites and gneisses which preliminary work indicates are not less than 2 billion years old.--Auth.

5. PALEONTOLOGY

See also: Areal and Regional Geology 2-2812; Stratigraphy 2-2858.

2-2865. Weller, J. Marvin. **DEVELOPMENT OF PALEONTOLOGY:** Jour. Paleontology, v. 34, no. 5, p. 1001-1019, Sept. 1960, 11 refs.

Four periods can be recognized in the development of paleontology. The first, or prescientific period, began with the ancient Greek philosophers and continued to the mid-18th century. Almost no progress was made during these 2,000 years. Fossils, correctly interpreted by some of the ancients, came to be recognized as organic objects. Various ideas were expressed regarding both rocks and fossils, bu very few observations of any real scientific value were made.

The second, or early scientific period, lasted for about 100 years and ended in the mid-19th century. During this time, geologic understanding rapidly advanced, and fossils attracted increasingly wide attention because of their strange nature and usefulness in correlation. Evolutionary theories originated, but religious beliefs caused their general rejection.

The middle scientific period began with Darwin and continued for most of the remaining 19th century. Evolution as a process gained wide acceptance and was applied in paleontology, but its mechanism was unsatisfactorily explained.

The modern scientific period has been marked by the perfection of genetic theory and its application to paleontologic studies. Biologic interest in fossils slowly but steadily expanded. Increasing consideration was given to the recognition of evolutionary patterns and proof of evolutionary theory. Geologic interest in fossils shifted gradually from their practical applications in correlation to paleoecology and its promise of providing a better understanding of physical environments of the past.--Auth.

2-2866. Saul, LouElla Rankin, and Richard B. Saul. **FOSSILS: WHAT THEY MEAN AND HOW TO COLLECT THEM: California, Div. Mines, Mineral Inf. Service, v. 13, no. 7, p. 1-7, illus., maps, July 1960, 40 refs.**

This brief article is directed to the amateur paleontologist. The concept of fossils as remains of animals and plants preserved in the rocks of the earth's crust was not accepted until relatively modern times. The present geologic time scale is based largely on the uniformitarian and evolutionary concepts of such men as Hutton and Darwin.

Fossils of diverse types and ages are relatively abundant in California. Collecting fossil material should be done in a systematic manner or the resulting collection will have little lasting value. Identification of fossils will be more or less time consuming depending upon the amount of previous work done on the fauna at hand. The collector must learn to use the literature, becoming familiar with the terminology of descriptions and the system of zoological nomenclature upon which names are based. Specimens should be adequately cleaned and stored and an orderly record kept.--Auth.

2-2867. Brann, Doris C., and Lois S. Kent. **CATALOGUE OF THE TYPE AND FIGURED SPECIMENS IN THE PALEONTOLOGICAL RESEARCH INSTITUTION: Bulls. Am. Paleontology, v. 40, no. 184, 995 p., 1960.**

This catalogue is an alphabetical list of the type specimens and the figured and unfigured specimens which have been included in publications and deposited in the Paleontological Research Institution, Ithaca, New York. Included for each specimen is its catalogue number, scientific name, author, type designation, complete reference, locality, and horizon. With the reference is such information as condition of specimen, changes in spelling, or other miscellaneous facts that might be helpful to the catalogue user. The locality has been extended to include the county or parish if in the United States or the smallest political subdivision in foreign countries. An attempt has been made to locate old or obscure localities, and the references that have been consulted which might assist the reader are cited.

Whenever necessary and possible the stratigraphy has been updated to conform to contemporary standards.--From introd.

2-2868. Sanders, John E. **THE BERINGER CASE: GeoTimes, v. 5, no. 1, p. 28-29, Sept. 1960.**

Johannes B. A. Beringer is best known in paleontology for having accepted as true paleontological specimens artifically figured stones described in his treatise Lithographiae Wirceburgensis (1726). Two aspects of the usually related story are 1) that Beringer's students prepared and distributed the stones where Beringer would find them, and 2) that Beringer thought the figured stones were fossils. Actually 2 of Beringer's adult colleagues were responsible for the hoax, most of the specimens were brought to Beringer, and lastly he did not think they were true fossils, i.e., of organic origin, although he failed to detect that they were the work of man.--M. Russell.

2-2869. Stevens, Calvin H., Daniel H. Jones, and Robert G. Todd. **ULTRASONIC VIBRATIONS AS A CLEANING AGENT FOR FOSSILS: Jour. Paleontology, v. 34, no. 4, p. 727-730, 2 pls., July 1960, 4 refs.**

Representative fossils from rocks of different ages and lithologies were subjected to relatively low frequency ultrasonic vibrations. An examination of the results showed that the cleaning accomplished is highly successful for many samples and that detrimental effects are rare unless cleaning is continued for an excessive length of time.--Auth.

2-2870. Millhauser, Milton. **JUST BEFORE DARWIN: ROBERT CHAMBERS AND VESTIGES: 246 p., 2 illus., Middletown, Connecticut, Wesleyan University Press, 1959, approx. 700 refs.**

In 1844, 15 years before Darwin's Origin of Species, there was published anonymously in England the book Vestiges of the Natural History of Creation. Drawing extensively from astronomy, geology, paleontology, biology, and philosophy, its author detailed a theory of evolution called the "development hypothesis." The book captured the imagination of English intellectuals who bought out 11 editions, more than 23,000 copies, in 16 years. At least as many more were sold in American editions, and 3 translations to the German were published. Until the appearance of Darwin's work, it was the most effective exponent of evolution in print.

The theory attempts to relate all aspects of the universe, the world, and life to a simplified law of progress. The author of the book, confirmed several years after his death by one of only 4 who knew, was Robert Chambers, a Scottish essayist, publisher, and geologist. This book is an analysis of Vestiges, its effect, and a biography of its author.--M. Russell.

2-2871. Calvin, Melvin. **ORIGIN OF LIFE ON EARTH AND ELSEWHERE: Lunar & Planetary Explor. Colloquium, Proc., v. 1, no. 6, p. 8-18, 4 illus., chart, 6 diags., Apr. 25, 1959, approx. 30 refs.**

The author traces a path from the primitive molecules of the primeval earth's atmosphere condensed from space; through the random formation of more or less complex organic molecules, using the available energy sources of ultraviolet light, ionizing radiation or atmospheric electrical discharge; through the selective formation of complex organic molecules via autocatalysis: finally, to the information-transmitting molecule which is capable of self-reproduction and variation. In addition, somewhere, either during the course of this "chemical evolution," or perhaps succeeding it, a system has been evolved in which the concentration of the reaction materials was retained in a relatively small volume of space, leading to the formation of cellular structures. Cellular life as we know it on the surface of the earth does exist in some millions of other sites in the universe.--From auth.

2-2872. Galloway, J.J. DEVONIAN STROMATOPOROIDS FROM THE LOWER MACKENZIE VALLEY OF CANADA: Jour. Paleontology, v. 34, no. 4, p. 620-636, 56 illus. on 7 pls., July 1960, 34 refs.

Twenty-four species of Middle and Upper Devonian stromatoporoids, belonging to 12 genera, are described and illustrated from the area between Norman Wells and Fort Good Hope in the lower Mackenzie Valley. The stromatoporoids agree specifically with those from Iowa, Indiana, England, Belgium, and Germany, from the lower Middle and lower Upper Devonian. Five new species were identified.--Auth.

2-2873. Fritz, Madeleine A., and B.F. Howell. CAMBROTRYPA MONTANENSIS, A MIDDLE CAMBRIAN FOSSIL OF POSSIBLE CORAL AFFINITIES: Geol. Assoc. Canada, Proc., v. 11, p. 89-92, 4 illus. on pl., Dec. 1959, 6 refs.

A small collection of fossils from the Middle Cambrian of Montana is described and illustrated. The specimens represent small tubular growths of uncertain affinities. It is believed that they are corals, but other possible biological relationships are discussed. --Auth.

2-2874. Kolosváry, G. THE PHYLOGENETIC CLASSIFICATION OF THE MADREPORARIAN CORALS: Jour. Paleontology, v. 34, no. 5, p. 1051-1053, chart, 2 tables, Sept. 1960, 2 refs.

It is proposed to classify the 8 suborders of Madreporarian corals under 3 groups as follows: 1) Conservative, suborder Amphiastraeida; 2) Elastic, suborders Stylinida, Archaeocaeniida, Meandriida; 3) Progressive and Regressive, suborders Astraeoida, Caryophylliida, Fungiida, and Eupsammida.--M. Russell.

2-2875. Rich, Mark. CHAETETES IN THE BIRD SPRING FORMATION NEAR LEE CANYON, CLARK COUNTY, NEVADA: Jour. Paleontology, v. 34, no. 4, p. 761-762, July 1960, 3 refs.

Chaetetes was found by the author only 1,085 ft. and 1,195 ft. above the base of the thick section of the Bird Spring formation (Mississippian-Pennsylvanian-Permian) N. of Lee Canyon, and stratigraphically between beds containing Profusulinella and Fusulinella. The Chaetetes-bearing beds in the Cordilleran region extend into the southern Nevada area. Confirmation of Atokan age must be based on relationship with fusulinids.--L.M. Dane.

2-2876. Howe, Herbert J. TURBINOLIA ROSETTA, A NEW CORAL SPECIES FROM THE PALEOCENE OF ALABAMA: Jour. Paleontology, v. 34, no. 5, p. 1020-1022, 2 illus., map, Sept. 1960, 3 refs.

A new coral species, Turbinolia rosetta, is described from the Midway group (Paleocene) of Alabama. This is only the second Turbinolia reported from Paleocene deposits.--Auth.

2-2877. Raup, David M. ONTOGENETIC VARIATION IN THE CRYSTALLOGRAPHY OF ECHINOID CALCITE: Jour. Paleontology, v. 34, no. 5, p. 1041-1050, sec., 9 diags., table, Sept. 1960, 15 refs.

In the coronal plates of some echinoid species, orientation of calcite c-axes is a function of growth. In Hemicentrotus pulcherrimus, the first formed plates (near the peristome) have c-axes that are nearly perpendicular to the plate or test surface; plates of intermediate age (near the ambitus) have axes inclined at an angle of approximately 45°; and the axes of the youngest plates (near the apical system) are again nearly perpendicular. In Lytechinus variegatus a different pattern obtains but a gradual change in orientation with growth is again observed. Other echinoid species studied do not exhibit ontogenetic variation in calcite crystallography.

It is suggested that the adaptive value of a given preferred orientation of c-axes is related to the organism's light sensitivity. Light will pass through a plate having a tangential c-axis more readily than through one having a more nearly perpendicular c-axis. Littoral echinoids with tangential c-axes commonly cover their tests with debris as a shield agains light.

Adaptation to light conditions in shallow water through changes in relative developmental rates (in species like H. pulcherrimus and L. variegatus) may be the explanation for the evolution of one preferred orientation from another in the geologic past.--Auth.

2-2878. Ross, June R.P. Phillips. RE-EVALUATION OF THE TYPE SPECIES OF ARTHROPORA ULRICH: Jour. Paleontology, v. 34, no. 5, p. 859-861, 11 illus. on pl., chart, Sept. 1960, 6 refs.

Syntypes of Arthropora shafferi (Meek), the type species of Arthropora, are found to belong to the genus Graptodictya. Thus Arthropora is a synonym of Graptodictya.--Auth.

2-2879. Perry, T.G., and Donald E. Hattin. OSGOOD (NIAGARAN) BRYOZOANS FROM THE TYPE AREA: Jour. Paleontology, v. 34, no. 4, p. 695-710, 6 pls., July 1960, 20 refs.

A bryozoan faunule including 15 species has been collected from the upper 5 ft. of the Osgood formation (Niagaran [Silurian]) as exposed in the Southeastern Materials Corporation quarry in the SW 1/4, sec. 22, T. 8 N., R. 11 E. at Osgood in Ripley County, Indiana. The following new species are established: Ceramopora vesicularis, Fistulipora promiscua, Heterotrypa? perplexa, Cyphotrypa osgoodensis, Stigmatella dubia, Hennigopora apta, and Monotrypa exserta. An unnamed species of Trematopora Hall is described. The bryozoans are associated with brachiopods, trilobites, corals, cystoids, nautiloids, and abundant arenaceous foraminifers. The fossils are embedded in gray highly calcareous shale that contains thin beds of gray coarse-grained argillaceous limestone.

The most abundantly represented genus is Fistulipora McCoy; specimens of this genus are assigned to the new species Fistulipora promiscua which displays considerable structural variability in tangential and longitudinal sections. The next most abundant genus is Monotrypa Nicholson which is represented by 3 species. Other bryozoan genera in this faunule include: Ceramopora Hall, Cheilotrypa Ulrich, Heterotrypa? Nicholson, Cyphotrypa Ulrich & Bassler, Stigmatella Ulrich & Bassler, Hennigopora Bassler, Hallopora Bassler, Trematopora Hall, Diplotrypa Nicholson, and Pachydictya Ulrich. Stignatella, Heterotrypa?, and Cyphotrypa have not been reported previously from the Osgood. Specimens of fenestellid bryozoans are rare and poorly preserved. -Auth.

-2880. Weller, J. Marvin. AUTHORSHIP OF NAME MESOLOBUS STRIATUS: Jour. Paleontology, . 34, no. 4, p. 762, July 1960.

The name Mesolobus striatus was proposed in 1933 or a Lower Pennsylvanian brachiopod by Weller and McGehee on sufficient enough basis that R.D. Hoare s unjustified in considering it a nomen nudum and claiming authorship.--M. Russell.

-2881. Crickmay, C.H. STUDIES OF THE WESTERN CANADA STRINGOCEPHALINAE: Jour. Paleontology, v. 34, no. 5, p. 874-890, 3 pls., 37 illus., map, Sept. 1960, 10 refs.

Three new and one old species of Stringocephalus are described and credited to occurrence positions in the Middle Devonian of western Canada. The types of all 4 species are from the northern Rocky Mountains. Other occurrences are listed from Lake Winnipegosis outcrops, several boreholes across Saskatchewan and Alberta, and other outcrops in northern Alberta, northeastern British Columbia, and the Northwest Territories. Formation nomenclature is examined and paleogeography is interpreted.--Auth.

-2882. Moore, Raymond C., ed., assisted by Charles W. Pitrat. TREATISE ON INVERTEBRATE PALEONTOLOGY. PART I. MOLLUSCA 1. MOLLUSCA - GENERAL FEATURES, SCAPHOPODA, AMPHINEURA, MONOPLACOPHORA, GASTROPODA - GENERAL FEATURES, ARCHAEOGASTROPODA AND SOME (MAINLY PALEOZOIC) CAENOGASTROPODA AND OPISTHOBRANCHIA, by J. Brookes Knight, L.R. Cox, A. Myra Keen, A.G. Smith, R.L. Batten, E.L. Yochelson, N.H. Ludbrook, Robert Robertson, C.M. Yonge, and R.C. Moore: 351 p., 216 figs., New York and Lawrence, Kansas, Geological Society of America and University of Kansas Press, 1960, refs.

Pt. 1 of 6 volumes on Mollusca in the 24-part authoritative and comprehensive treatise on invertebrate paleontology. Mollusca, pt. 4 (ammonoid cephalopods) was published in 1957. The scope of this volume is indicated from the following composite table of contents.--M. Russell.

- Introduction (R.C. Moore)
- General Characters of Mollusca (C.M. Yonge)
  - Definition of Mollusca
  - Affinities
  - General Features
  - Class Monoplacophora
  - Class Polyplacophora
  - Class Aplacophora
  - Class Gastropoda
  - Class Pelecypoda
  - Class Scaphopoda
  - Class Cephalopoda
- Scaphopoda (N.H. Ludbrook)
- Amphineura (A.G. Smith)
  - Introduction
  - Polyplacophora
  - Aplacophora
  - Systematic Descriptions
- Monoplacophora (J. Brookes Knight and E.L. Yochelson)
- Gastropoda - General Characteristics of Gastropoda (L.R. Cox)
  - Name and Definition of Class
  - Biology
  - Morphology of Soft Parts
  - Morphology of Hard Parts
  - Fossil Traces of Gastropoda
  - Ontogeny
  - Evolution of Gastropoda
  - Gastropod Classification
- Systematic Descriptions [Archaeogastropoda] (J. Brookes Knight, L.R. Cox, A. Myra Keen, R.L. Batten, E.L. Yochelson, and Robert Robertson)
  - Introduction
  - Class Gastropoda Cuvier, 1797
  - Subclass Prosobranchia Milne Edwards, 1848
  - Order Archaeogastropoda Thiele, 1925
    - Suborder Bellerophontina Ulrich & Scofield, 1897
      - Superfamily Helcionellacea Wenz, 1938
      - Superfamily Bellerophontacea M'Coy, 1851
    - Suborder Macluritina Cox & Knight, 1960
      - Superfamily Macluritacea Fischer, 1885
      - Superfamily Euomphalacea deKoninck, 1881
    - Suborder Pleurotomariina Cox & Knight, 1960
      - Superfamily Pleurotomariacea Swainson, 1840
      - Superfamily Trochonematacea Zittel, 1895
      - Superfamily Fissurellacea Fleming, 1822
    - Suborder Patellina von Ihering, 1876
      - Superfamily Patellacea Rafinesque, 1815
      - Superfamily Cocculinacea Thiele, 1909
    - Suborder Trochina Cox & Knight, 1960
      - Superfamily Platyceratacea Hall, 1859
      - Superfamily Microdomatacea Wenz, 1938
      - Superfamily Anomphalacea Wenz, 1938
      - Superfamily Oriostomatacea Wenz, 1938
      - Superfamily Trochacea Rafinesque, 1815
    - Suborder Neritopsina Cox & Knight, 1960
      - Superfamily Neritacea Rafinesque, 1815
    - ? Suborder Murchisoniina Cox & Knight, 1960
      - Superfamily Murchisoniacea Koken, 1896
    - Superfamilies of doubtful subordinal position
      - Superfamily Clisospiracea S. A. Miller, 1889
      - Superfamily Pseudophoracea S. A. Miller, 1889
      - Superfamily Craespedostomatacea Wenz, 1938
      - Superfamily Palaeotrochacea Knight, 1956
      - Superfamily Amberleyacea Wenz, 1938
    - ? Archaeogastropoda Genera inquirenda
- Supplement. Paleozoic and Some Mesozoic Caenogastropoda and Opisthobranchia (J.B. Knight, R.L. Batten, E.L. Yochelson, and L.R. Cox)
  - Introduction
  - Order Caenogastropoda Cox, 1959
    - Superfamily Loxonematacea Koken, 1889
    - Superfamily Cerithiacea Fleming, 1822
    - Superfamily Cyclophoracea Gray, 1847
    - Superfamily Rissoacea Adams & Adams, 1854
    - Superfamily Subulitacea Lindström, 1884
  - Subclass Opisthobranchia Milne Edwards, 1848
    - Order Uncertain
      - Superfamily Pyramidellacea d'Orbigny, 1840
    - Order Pleurocoela Thiele, 1925
      - Superfamily Acteonacea d'Orbigny, 1842

?Gastropoda Incertae Sedis
  Superfamily Pelagiellacea Knight, 1956
 Generic names assigned to Paleozoic fossils
  improperly regarded as Gastropoda and
  Monoplacophora
Supplement. Paleozoic and Some Mesozoic Caenogastropoda and Opisthobranchia (J. Brookes Knight, R.L. Batten, E.L. Yochelson, and L.R. Cox).

2-2883. Murphy, Michael A., and Peter U. Rodda. **MOLLUSCA OF THE CRETACEOUS BALD HILLS FORMATION OF CALIFORNIA. PART I: Jour. Paleontology, v. 34, no. 5, p. 835-858, 7 pls., map, chart, secs., Sept. 1960, 24 refs.**

A well preserved molluscan fauna has been collected from previously undescribed Cretaceous rocks in the northwestern Sacramento Valley, California. The fossils occur in the Bald Hills formation, a 1,000-ft. to 1,900-ft. thick SE.-dipping conglomerate, graywacke, and mudstone unit which ranges in age from late Albian to late Cenomanian. The gastropod and cephalopod elements of this fauna number 32 species, 17 of which are new.

New species described are: Solariella stewarti, Tessarolax trinalis, Gyrodes allisoni, Gyrodes greeni, Ampullina stantoni, Ampullina mona, Euspira popenoei, Euspira marianus, Paleosephaea sacramentica, Clinura anassa, Acteon sullivanae, Cylichia andersoni, Mariella (Mariella) fricki, Turrilites (Turrilites) dilleri, Puzosia puma, Puzosia sullivanae, Eogunnarites matsumotoi.--Auth.

2-2884. Valentine, James W., and Robert F. Meade. **ISOTOPIC AND ZOOGEOGRAPHIC PALEOTEMPERATURES OF CALIFORNIAN PLEISTOCENE MOLLUSCA: Science, v. 132, no. 3430, p. 810-811, table, Sept. 23, 1960, 3 refs.**

Pleistocene paleotemperatures inferred from zoogeographic evidence are based on temperatures at species' range limits at present. Paleotemperatures inferred from isotopic evidence are based on average former shell-growth temperatures which commonly, but not exclusively, lie between present range-limiting temperatures. With allowance for these differences, the 2 lines of evidence suggest similar thermal patterns.--Auth.

2-2885. Valentine, James W. **PLEISTOCENE MOLLUSCAN NOTES, 3. ROCKY COAST FAUNULE, BAHIA SAN QUINTIN, MEXICO: Nautilus, v. 74, no. 1, p. 18-23, table, July 1960, 13 refs.**

Thirty-one species of mollusks, an echinoid, and a crab fragment are recorded from an upper Pleistocene silty rubble of chiefly volcanic debris on the W. side of Bahia San Quintin, Baja California, on the flank of an ancient volcano. The association contains chiefly muddy- and rocky- or shelly-bottom species and includes a few intertidal forms. Most of the rock-dwellers tolerate quiet waters, whereas chiefly exposed-shore forms are rare. The faunule is interpreted as having lived in quiet tidal and shallow subtidal zones on and in a rock- and shell-strewn muddy bottom. A small northern element suggests that the temperature regime was different from that of today. --Auth.

2-2886. Krinsley, David H. **MAGNESIUM, STRONTIUM, AND ARAGONITE IN THE SHELLS OF CERTAIN LITTORAL GASTROPODS: Jour. Paleontolog v. 34, no. 4, p. 744-755, 2 diags., 5 tables, July 1960, 26 refs.**

Sr, Mg, and aragonite percentages were examine in modern and fossil shells of Tegula funebralis, Olivella biplicata, and Fissurella volcano. Statisti tests were used to determine whether differences existed between modern and fossil locality means and variances with respect to the 3 measures liste above. Sr was relatively stable with time in the sh material examined, while Mg was mobile; aragonit percentages also appeared to be stable during the time period examined. Mg in shell material of the same species at 2 different locations of the same a reacted differently to postdepositional change.--Au

2-2887. Wells, John W. **A PLEISTOCENE MARINE MOLLUSK IN CENTRAL NEW YORK: Nautilu v. 74, no. 1, p. 26-28, illus., July 1960, 3 refs.**

A bryozoan-encrusted gastropod identified as Neptunea sp. cf. N. antiqua (Linn.) was found in a concretion in Wisconsin drift 1 mi. S. of Ithaca, New York. The concretion is composed of nonstratified gray silt with minute plant fragments and shell chips. The nearest known marine Pleistocene deposits are in the St. Lawrence and Champlain va leys, but concretions reported there are not lithologically similar to the Ithaca specimen. Neptunea is known from the Pleistocene of Quebec and localities farther E. Perhaps the Ithaca specimen is a relic from a Canadian deposit that has been swept away by Wisconsin ice.--J. W. Valentine.

2-2888. Leonard, A. Byron, and Tong-Yun Ho. **NEW CALIPYRGULA FROM PLEISTOCENE OF TE AS AND NOTES ON COCHLIOPA RIOGRANDENSIS: Nautilus, v. 73, no. 4, p. 125-129, illus., Apr. 19 3 refs.**

Calipyrgula circumstriata n. sp. (Mollusca: Gastropoda) is based on shells from late Pleistocen terrace deposits along the Pecos River, where the river entrenches Cretaceous rocks in southwester Texas. A habitat in clear, cool, rocky streams is suggested by comparison with certain present tribu taries of the Pecos River and by the associated gastropod Cochliopa riograndensis, a poorly know species discovered living in one of these tributarie The radula and operculum of C. riograndensis are described, evidently for the first time.--J. W. Valentine.

2-2889. Ruzhencev, V.E. **AMMONOID CLASSIF CATION PROBLEMS: Jour. Paleontology, v. 34, no. 4, p. 609-619, 4 diags., July 1960, 32 refs.**

A genetic terminology of the ammonoid suture li is defined and some doubtful aspects of this genera problem are considered. Study of ontogenetic sutu al development is shown to be most significant in ammonoid classification. Five orders of Ammono dea (Agoniatitida, Goniatitida, Clymeniida, Cerati and Ammonitida) are recognized and defined.--Aut

2-2890. Murray, Grover E., W.M. Furnish, a José Carrillo B. **CARBONIFEROUS GONIATITES FROM CABALLEROS CANYON, STATE OF TAMA LIPAS, MEXICO: Jour. Paleontology, v. 34, no. p. 731-737, 3 maps, 4 diags., July 1960, 20 refs.**

A few moderately well preserved ammonoid fra ments from the Sierra Madre Oriental of southwes

Tamaulipas represent a known Atokan species,
udoparalegoceras amotapense (Thomas). These
the first such fossils of this age between central
xas, some 500 mi. N., and where the species was
st described, over 2,500 mi. SE. in northern Peru.
sociated fauna includes another goniatite, Eoasia-
es sp., and a primitive fusulinid, Fusulinella sp.
Auth.

891. Kummel, Bernhard. TRIASSIC AMMO-
IDS FROM THAILAND: Jour. Paleontology, v.
no. 4, p. 682-694, 2 pls., 2 maps, July 1960,
refs.

The first Triassic ammonoids to be recorded from
ailand demonstrate the presence of Anisian and
rnian formations. The Anisian is represented by
ecies of Balatonites, Ptychites, Tropigymnites,
yrichites, and Sturia; the Karnian is represented
species of Joannites, Cladiscites, Trachyceras
ratrachyceras), and Lobites. The occurrence and
lationships of Triassic marine formations in SE.
ia are briefly reviewed.--Auth.

2892. Tillman, C.G. SPATHACALYMENE, AN
USUAL NEW SILURIAN TRILOBITE GENUS: Jour.
leontology, v. 34, no. 5, p. 891-895, 12 illus.
pl., Sept. 1960, 8 refs.

Calymene nasuta Ulrich, from the Middle Silurian
sgood formation of southeastern Indiana, is re-
scribed on the basis of type material from the U.S.
ational Museum and a new, nearly complete speci-
en. It is characterized by the possession of a
atulate anterior border process and is designated
e type species of Spathacalymene n. gen.--Auth.

-2893. Robison, Richard A. SOME DRESBACH-
N AND FRANCONIAN TRILOBITES OF WESTERN
TAH: Brigham Young Univ., Dept. Geology, Brig-
m Young Univ. Research Studies, Geology Ser.,
7, no. 3, 59 p., 4 pls., map, sec., table, Apr.
60, 57 refs.

The purpose of this paper is to describe system-
ically the Dresbachian and Franconian trilobite
una of western Utah and to extend previously de-
ed Upper Cambrian faunal zones into this region.
ossils were collected from 10 measured sections in
estern Utah, from the Deep Creek Range near the
evada line on the W. to Provo Rock Canyon in cen-
al Utah on the E., and N.-S. from the Silver Island
nge to the Wah Wah Mountains.

In the vicinity of the House Range, where the thick-
t section is found, the Upper Cambrian is com-
ised of the Weeks, Orr, Dunderberg, and Notch
ak formations. Upper Cambrian rocks of central
ah have been subdivided into 3 units known as the
pex, Dunderberg, and Ajax formations.

Representatives of 6 of the 7 standard Upper Cam-
ian trilobite zones have been recognized. They
e, from oldest to youngest: Cedaria, Crepicephalus,
helaspis, Elvinia, Ptychaspis-Prosaukia, and
ukia. The Cedaria, Crepicephalus, and Elvinia
nes are the most prolific in numbers of trilobite
ecies preserved, but the Aphelaspis zone is by far
e most abundantly fossiliferous zone encountered.
fty-two trilobite species have been identified and
ost of them are described.

Faunal evidence indicates that the Weeks and Orr
rmations are equivalent to the Lamb and Hicks for-
ations in western Utah, and to the Opex dolomite
central Utah. The name, Dunderberg shale, has been extended from central Nevada into western Utah for the widespread shale unit which marks the base of the Franconian. The Notch Peak limestone of western Utah is equivalent to the Ajax limestone of central Utah.--Auth.

2-2894. Frey, David G. ON THE OCCURRENCE OF CLADOCERAN REMAINS IN LAKE SEDIMENTS: Natl. Acad. Sci., Proc., v. 46, no. 6, p. 917-920, 3 tables, June 1960, 12 refs.

A population study based on cladoceran remains collected from dredged sediment samples of 5 Madison, Wisconsin, lakes. A more complete, more quickly assembled, species list of chydorids is obtained by such a study than by collections of living animals. Relations between the cladoceran population and various sediment parameters suggest means in paleolimnologic studies to deduce past levels of plankton production and lake morphometry.--M. Russell.

2-2895. Schlaudt, C.M., and Keith Young. ACROTHORACIC BARNACLES FROM THE TEXAS PERMIAN AND CRETACEOUS: Jour. Paleontology, v. 34, no. 5, p. 903-907, 2 pls., 3 diags., Sept. 1960, 8 refs.

Rogerella cragini, n. sp., a burrow of a heretofore undescribed species of acrothoracic barnacle, is restricted to host shells of Ceritella proctori (Cargin), a gastropod. R. cragini is known only from the Edwards limestone (middle Albian [Cretaceous]) of Travis County, Texas.

A second, indeterminate, acrothoracic barnacle burrow occurs on silicified shells from the Word formation [Permian] of the Glass Mountains, Texas.--Auth.

2-2896. Leutze, Willard P. SILURIAN EURYPTERIDS FROM WEST VIRGINIA: Jour. Paleontology, v. 34, no. 5, p. 1023-1026, illus., Sept. 1960, 5 refs.

Eurypterids have been reported at only 4 places in West Virginia. A new eurypterid horizon is described at one of these localities. At least 4 genera are present in the Wills Creek formation. A single fragment of an Eurypterus may have been obtained from the overlying Tonoloway formation. The prosoma of Dolichopterus cumberlandicus Swartz is redescribed on the basis of a newly discovered specimen.--Auth.

2-2897. Roberts, David C. THE CLEVELAND SHALE AND ITS FOSSILS: Cleveland Mus. Nat. History, Mus. News, v. 2, no. 7, p. 83-93, 5 illus., map, July 1960, 4 refs.

The Devonian Cleveland shale outcrops in valleys and ravines along the shore of Lake Erie and contains a fish fauna known to paleontologists throughout the world. It contains a rich arthrodire fauna of which the most famous is Dunkleosteus; also particularly noteworthy is the occurrence of Cladoselache, the oldest shark whose body is known.--M. Russell.

2-2898. Macdonald, J.R. AN EARLY PLIOCENE FAUNA FROM MISSION, SOUTH DAKOTA: Jour. Paleontology, v. 34, no. 5, p. 961-982, 13 illus., map, graph, tables, Sept. 1960, 14 refs.

A Clarendonian mammalian fauna from a sand pit near Mission, South Dakota, is described. The material comprising this fauna was collected during the operation of the sand pit for highway construction select borrow. Due to these operations the remains, although abundant, are quite fragmentary. The fauna is a correlative of the Big Spring Canyon fauna from Martin, South Dakota. A new species of camel, Procamelus foxi, is described.--Auth.

2-2899. Turnbull, William D. A LANCE DIDELPHID MOLAR, WITH COMMENTS ON THE PROBLEMS OF THE LANCE THERIANS: Chicago, Nat. History Mus., Fieldiana: Geology, v. 10, no. 36, p. 525-537, 4 illus., diag., 3 tables, July 22, 1960, 8 refs.

An unworn, unrooted lower molar tooth of a Lance [Cretaceous] didelphid, found in the University of Chicago collection and apparently forgotten since 1895, may be helpful in determining the affinities of many previously unidentifiable lower molars. Detailed study of this tooth suggests statistical studies, particularly of the dentition of Recent didelphids, which would provide useful bases of comparison.--M. Russell.

2-2900. Russell, Dale A. A REVIEW OF THE OLIGOCENE INSECTIVORE MICROPTERNODUS BOREALIS: Jour. Paleontology, v. 34, no. 5, p. 940-949, 4 illus., Sept. 1960, 18 refs.

A rostrum from the Chadronian of Pipestone Springs, Montana, is referred to Micropternodus borealis Matthew. Kentrogomphios strophensis White is a junior synonym of M. borealis, as may be the Cryptoryctes kayi Reed humeri. Micropternodus cannot be placed in the Talpidae, Solenodontidae, Apternodontidae, or the Nyctitheriidae, as has been variously suggested by previous authors, but rather belongs in a poorly-known complex of late Cretaceous and early Tertiary insectivores represented by Gypsonictops, Scenopagus, and the Geolabidinae.--Auth.

2-2901. Mawby, John E. A NEW AMERICAN OCCURRENCE OF HETEROSOREX GAILLARD: Jour. Paleontology, v. 34, no. 5, p. 950-956, 4 illus., table, Sept. 1960, 11 refs.

A jaw of Barstovian age [Tertiary] from Oregon resembles Heterosorex sansaniensis (Lartet) and is probably a new North American species of that genus. Domnina compressa Galbreath [from Colorado] is a primitive heterosoricine and should be referred to the genus Heterosorex.--Auth.

2-2902. Straus, William L., Jr., and Miguel A. Schön. CRANIAL CAPACITY OF OREOPITHECUS BAMBOLII: Science, v. 132, no. 3428, p. 670-672, illus., table, Sept. 9, 1960, approx. 15 refs.

From a plaster reconstruction of the skull of the Aug. 1958 skeleton, the cranial capacity of Oreopithecus bambolii [fossil catarrhine primate, lower Pliocene, Italy] has been estimated as falling between 276 and 529 cu. cm., thus within the ranges of variation of both orangutan and chimpanzee. In cranial capacity, therefore, and probably in body-brain ratio as well, Oreopithecus is a hominoid.--Auth.

2-2903. Wilson, John Andrew. MIOCENE CARNIVORES, TEXAS COASTAL PLAIN: Jour. Paleontology, v. 34, no. 5, p. 983-1000, 9 figs. incl. illus., chart, 3 diags., 3 tables, Sept. 1960, 30 refs.

Daphaenodon is recognized in Texas for the firs time where it is associated with Amphicyon. Amphi yon, a European genus, spread to North America during late early Miocene time and is found on the Gulf Coast in rocks of that age to latest Miocene or earliest Pliocene. On the basis of the presently known material, both A. pontoni Simpson and A. longiramus White can be identified. Aleurodon francisi Hay is reconfirmed as belonging to that genus. The presence of Tomarctus canavus (Simpson) and Cynodesmus iamonensis (Sellards) is recognized, which extends the range of these species from Florida to the Texas Coastal Plain. Edaphocy pointblankensis n. gen. et n. sp., a procyonid of close relationship to Bassariscus, is described.--Auth.

2-2904. Schmaltz, Lloyd J. OCCURRENCE OF VERTEBRATE REMAINS IN NEBRASKAN TILL OF NORTH-CENTRAL MISSOURI: Jour. Paleontology, v. 34, no. 4, p. 762, July 1960.

The first reported find of vertebrate remains from Nebraskan till in Missouri are tentatively iden tified as representing the proximal end of the right femur of Equus complicatus. Locale is western cit limits of Macon, Macon County.--M. Russell.

2-2905. Burt, Alvin M., and Albert E. Wood. VARIANTS AMONG MIDDLE OLIGOCENE RODENT AND LAGOMORPHS: Jour. Paleontology, v. 34, nc 5, p. 957-960, 7 diags., table, Sept. 1960, 4 refs.

Dental variations are described in specimens of 4 species of rodents and 1 rabbit, mostly considere to be individual variation. One specimen of Paradji daumo is structurally close to Adjidaumo. A varian in the structure of the masseter muscle of Ischyromys troxelli is recorded. Roots are shown to be formed on the teeth of numerous rabbits referable on a structural basis to Palaeolagus haydeni.--Auth.

2-2906. Reeder, William G. TWO NEW RODENT GENERA FROM THE OLIGOCENE WHITE RIVER FORMATION (FAMILY HETEROMYIDAE): Chicago Nat. History Mus., Fieldiana: Geology, v. 10, no. 35, p. 511-524, 6 illus., diag., 2 tables, July 22, 1960, 7 refs.

Apletotomeus crassus and Akmaiomys incohatus, both n. g., n. sp., heteromyid rodents, are erected on the basis of lower jaws with dentition, from the middle Oligocene Brule and White River formations of the Great Plains.--M. Russell.

2-2907. Todd, Ruth. RECENT LITERATURE ON THE FORAMINIFERA: Cushman Found. Foraminiferal Research, v. 11, pt. 3, p. 104-107, July 196

Sixty-eight briefly annotated references are give arranged alphabetically by author. References are world-wide and mainly from the period 1959-1960.

2-2908. Gutschick, Raymond C. PHOTOGRAPHY OF PALEOZOIC ARENACEOUS FORAMINIFERA: Jour. Paleontology, v. 34, no. 4, p. 756-758, diag July 1960, 9 refs.

A method is outlined for photographing Paleozoic arenaceous Foraminifera, particularly those obtain

om acid residues. Instructions cover preparation
specimens, photographic equipment used and its
rangement, lighting, developing, and printing.
ghting is the most critical factor.--M. Russell.

2909. Kling, Stanley A. PERMIAN FUSULINIDS
ROM GUATEMALA: Jour. Paleontology, v. 34,
. 4, p. 637-655, 5 pls., map, sec., 4 charts, diag.,
ly 1960, 24 refs.

Upper Paleozoic marine rocks were recognized in
entral America late in the nineteenth century, and
eir character and distribution were made known in
reconnaissance study by Karl Sapper (1896-1937).
ey occur in a narrow folded and faulted belt, 20 to
mi. wide, extending eastward from Chiapas, Mex-
o, through Guatemala to British Honduras. In most
aces, the sequence can be divided into a lower shale
vision, several thousands of feet thick, called the
nta Rosa formation by most investigators, and an
per division of 1,000 to 2,000 ft. of limestone and
lomite to which various names have been applied:
rupera, La Vainilla, and Paseo Hondo in Mexico,
d Karbonkalk and Chochal in Guatemala. The Up-
r Paleozoic rocks are thought to overlie, uncon-
rmably, older metamorphic rocks, and are over-
in, unconformably, by red beds of the Mesozoic
odos Santos formation.

Fossil collections obtained from these rocks by
arious investigators indicate ages ranging from
arboniferous to Permian. The lower part of the
anta Rosa formation usually has been assigned to
e upper Pennsylvanian throughout the outcrop belt.
ower and middle Permian fusulinids have been re-
orted from the limestone sequence in Chiapas and
uatemala. In British Honduras, Pennsylvanian
rachiopods have been reported from the lower part
f the sequence and a middle Permian ammonoid
rom near the top.

The present investigation of the upper Paleozoic
equence in Guatemala has provided new and more
omprehensive fusulinid collections. Among them,
pecies of the genera Eoverbeekina, Schubertella,
chwagerina, and Parafusulina are recognized. One
pecies of each of the 4 genera was recognized pre-
iously in Chiapas, Mexico, and 1 species of Para-
usulina in Guatemala. Three new species of Para-
usulina are described: P. erratosoptata, P. bitur-
inata, and P. subrectangularis. One identifiable
pecies from the uppermost part of the Santa Rosa
ormation in Guatemala indicates a Permian age for
few hundred feet of shale near the top of the forma-
ion. Similarity of a number of species to forms
rom the Permian of Texas strongly indicates ages
f Wolfcampian, Leonardian, and early Guadalupian
or the massive limestone sequence. The Pennsylva-
ian-Permian boundary, as yet unidentified, evidently
ies within the shale section.

The upper Paleozoic sequence appears to change
acies from W. to E. In Mexico and Guatemala, it
onsists mainly of shale and limestone with sandstone
onspicuously absent, while in British Honduras,
andstones and shales are dominant with only a few
in beds of limestone. A terrigenous source to the
. is suggested.--Auth.

-2910. Jones, James I. THE SIGNIFICANCE OF
ARIABILITY IN PRAEGLOBOTRUNCANA GAUTI-
RENSIS (BRÖNNIMANN), 1952, FROM THE CRE-
ACEOUS EAGLE FORD GROUP OF TEXAS: Cush-
an Found. Foraminiferal Research, Contr., v. 11,
. 3, no. 212, p. 89-103, pl., diag., 6 graphs,
uly 1960, 18 refs.

The establishment of a preferred dextral coiling direction is demonstrated for the species Praeglobotruncana gautierensis (Brönnimann) from Texas Cretaceous strata ranging in age from lower Cenomanian to middle Campanian.

The morphologic characters height and width of test, and height and width of chambers 1 and 4, as here defined, may be used to demonstrate minor morphologic variability by utilizing the techniques of this study.

A high degree of correlation exists between variation in the benthonic index as here defined and test morphologic variability as measured by the coefficient of variation in the species P. gautierensis from the Texas Cretaceous.

The coefficient of relative dispersion about the reduced major axis and the standard deviation of the total dispersion about the reduced major axis may be effectively used to measure minor morphologic variation in the species P. gautierensis.--Auth.

2-2911. Hofker, Jan. PLANKTONIC FORAMINIFERA IN THE DANIAN OF DENMARK: Cushman Found. Foraminiferal Research, Contr., v. 11, pt. 3, no. 210, p. 73-86, 38 figs., 5 tables, July 1960, 26 refs.

Planktonic Foraminifera, since they form 50-100% of the total foraminiferal populations, indicate that the type Danian of Denmark is a deep-sea sediment. Globigerines, especially G. daubjergensis Brönnimann, G. pseudobulloides Plummer and G. triloculinoides Plummer, show distinct orthogenetic changes during Danian time. These orthogenetic developments can be checked by the orthogenetic increase of pore diameters of Gavelinopsis involuta Reuss. The total gradual change in the whole planktonic assemblage, including Guembelina, Stainforthia (Chiloguembelina) and Guembelitria, during the Danian stage is also striking. At the boundary between Wind's zones III and IV, discontinuities in the orthogenetic changes were distinguished and lead to the conclusion that shifting of the deep-sea bottom took place. A short analysis of Chiloguembelina shows that it should be incorporated in the genus Stainforthia. The same stages of development of Globigerina daubjergensis and G. pseudobulloides in the Maestrichtian Chalk tuff and during the Danian of Denmark show that the type Maestrichtian of Dumont can be correlated with the Danian of Denmark.

The samples used are stored at the Geologisch Bureau, Heerlen, Holland; the faunas and species described are stored in the foraminiferal collections of the Geologische Dienst (Geological Survey) at Haarlem, Holland.--Auth.

2-2912. Bandy, Orville L. THE GEOLOGIC SIGNIFICANCE OF COILING RATIOS IN THE FORAMINIFER GLOBIGERINA PACHYDERMA (EHRENBERG): Jour. Paleontology, v. 34, no. 4, p. 671-681, 7 figs. incl. illus., 3 maps, graphs, table, July 1960, 17 refs.

Studies of Recent populations of the planktonic foraminifer, Globigerina pachyderma (Ehrenberg), show that more than 98% of Arctic and Antarctic specimens coil in a counter-clockwise direction (sinistral), whereas populations in temperate and tropical regions are mostly 98% clockwise (dextral) in manner of coiling. Basin cores off southern California reveal that modern dextral forms have persisted for about 11,000 years and were preceded by sinistral populations in the late Pleistocene, as determined by radiocarbon dating. Computations of sedimentation rates indicate that Pleistocene sediments were deposited from 25 to 500% faster than those in the Recent.

Investigation of populations in Pliocene and Pleistocene strata of southern California show consistent sinistrality in the Pleistocene and in the middle part of the Pliocene. Assemblages from the upper and lower Pliocene are dominantly dextral. Thus, an additional stratigraphic tool is provided in improving the accuracy of late Cenozoic correlations of southern California.--Auth.

2-2913. Hamlin, William H. TWO NEW SPECIES OF FORAMINIFERA FROM THE WEST COAST OF THE UNITED STATES: Cushman Found. Foraminiferal Research, Contr. v. 11, pt. 3, no. 211, p. 87-88, pl., July 1960, 3 refs.

Examination of shallow water samples collected from northern California and Oregon coasts disclosed 2 new species of Foraminifera: Massilina crescentensis and Trichohyalus orfordensis.--Auth.

2-2914. Uchio, Takayasu. ECOLOGY OF LIVING BENTHONIC FORAMINIFERA FROM THE SAN DIEGO, CALIFORNIA, AREA: Cushman Found. Foraminiferal Research, Spec. Pub. no. 5, 72 p., 18 figs. incl. maps, 10 pls., 9 tables, Apr. 1960, 83 refs.

One hundred and fifty-seven samples from the sea floor off San Diego, California, were studied for both living and total (living plus dead) populations of Foraminifera.

Seven benthonic Foraminifera depth assemblages are recognized on the basis of the living distributions and abundances. The boundaries are at depths of approximately 13, 45, 100, 250, 350, and 450 fathoms. Based on the Scripps Institution's study of hydrography it appears that the 13-fathom boundary may be interpreted as approximating the base of the turbulent zone, the 45-fathom boundary the bottom of the seasonal thermocline, the 100-fathom boundary the bottom of the California current, the 250-fathom boundary the top of the permanent thermocline, the 350-fathom boundary the oxygen minimum layer, the 450-fathom boundary the bottom of the permanent thermocline. The shallowest assemblage is divided into 2 facies, and difference of sediment types may be one of the principal causes of such differentiation.

Comparison of depth ranges of living and empty tests of 95 species shows that some of the tests of almost all species are transported toward deeper water after death. Total population counts are valid in defining the general composition and distribution where little or no displacement of sediment is expected, but generally these counts are not indicative of distribution of living specimens. Maximum abundance of living benthonic Foraminifera occurs between 55 and 150 fathoms and approximately coincides with the greatest number of species and genera. Temperature, food, and sediment type are considered important factors for depth distribution and size of population of living benthonic Foraminifera.

Ratios of living to total populations from sediment samples appear to be indicative of the rate of sedimentation. The ratios support the suggestion of Dietz that sediments from the land are deposited either nearshore or on the lower part of the continental slope and in basins, bypassing the outer shelf and upper continental slope. Rates of sedimentation calculated from an assumed rate of reproduction of Foraminifera are 97 years per cm. of sediment in the San Diego trough and 0.36 years per cm. in the nearshore area.

Three methods of calculating the amount of sea level change by using benthonic Foraminifera are discussed. Five to 10 fathoms of deepening is sug gested at some time later than the Pleistocene.

The presence of shallow-water Foraminifera ar Pleistocene Foraminifera in sand layers of a claye silt core, and in sandy silt on the surface of the floor of the San Diego trough, where clayey silts usually are found, proves displacement of sedimen from shallow to deep water.

Siltstones were cored at 3 stations in and near Loma sea valley and Coronado canyon, and are Miocene in age based on assemblages of Foraminifer diatoms, and Radiolaria.

One hundred and sixty species of benthonic Foraminifera are figured, of which 70 species are discussed as to their ranges of variation of forms and or synonymies. Two new genera are described: Paradentalina and Recurvoidella; 34 new species ar described: Ammomarginulina sandiegoensis, Aren parrella oceanica, Asterigerinata pacifica, Bigenerina hoeglundi, Bolivina peirsonae, B. subargente Buccella angulata, Cassidulina bradshawi, C. subcarinata, Cassidulinoides waltoni, Cibicides phleg Cornuspira lajollaensis, Eggerella scrippsi, Epistominella sandiegoensis, Globobulimina hoeglundi Gyroidina quinqueloba, Haplophragmoides neobrad H. quadratus, Involutina hoeglundi, Karreriella parkerae, Nonion lankfordi, N. parkerae, Nonione la (?) fragilis, Recurvoidella parkerae, Spiroloculi fragilis, Spiroplectammina bathyea, Textularia sandiegoensis, Trochammina chitinosa, T. discor noides, T. labiata, T. rhumbleri, Virgulina apert V. delicatula, V. sandiegoensis.--Auth.

2-2915. Dow, Verne E. MAGNETIC SEPARATI OF CONODONTS: Jour Paleontology, v. 34, no. 4 p. 738-743, 2 diags., July 1960, 3 refs.

A rapid convenient means of conodont concentra tion with the Frantz Isodynamic Magnetic Separato is described. Results with various types of residu are discussed and factors established for use of the instrument for this purpose.--Auth.

2-2916. Shaver, Robert H. THE PENNSYLVANI OSTRACODE BAIRDIA OKLAHOMAENSIS IN INDIAN Jour. Paleontology, v. 34, no. 4, p. 656-670, illu map, 9 graphs, 4 tables, July 1960, 34 refs.

A historical review of the ostracode Bairdia oklahomaensis, s.l., recalls that the species is especi ly common among Pennsylvanian faunas of the Illino basin and the midcontinent but that many concepts under at least 4 names have been applied to this sp cies. Earlier confusion resulting from the traditi al typological approach to Bairdia does not permit to accept safely any concept except the all-inclusiv one. The species, therefore, had been assigned a very long range, Morrow into Missouri, and had little or no stratigraphic value.

The triangular graph is a useful tool for the inte pretation of a quantitative study of 12 populations o Bairdia oklahomaensis, s.l., from throughout the vertical and lateral range of this species in Indiana Vertical speciation occurred, and so B. oklahomae sis, s.s., and B. dornickhillensis are recognized separately with respective ages of post-Atoka and pre-Des Moines and with further refinements in ea of their stratigraphic ranges. B. auricula and B.

seminalis (Payne only) should be considered as synonyms of B. oklahomaensis, s. s. Geographic speciation or subspeciation apparently did not occur within the broader concept of the species. The triangular graph shows further that the considerably different mean sizes among the several populations are of no genetic or taxonomic significance.

The ontogeny of Bairdia oklahomaensis, with 9 molt stages, does not differ importantly from that of modern species of Bairdia. The more recent name Nesidea, sometimes substituted for Bairdia, should be considered as a synonym.--Auth.

2-2917. Winkler, Erhard M. POST-PLEISTOCENE OSTRACODES OF LAKE NIPISSING AGE: Jour. Paleontology, v. 34, no. 5, p. 923-932, 3 pls., Sept. 1960, 16 refs.

A small ostracode fauna is described from lake silts about 4,000 years old of Lake Nipissing age from Bear Cave, Michigan. Seven genera and 14 species were found, 3 of which are new. About half of these species were previously described as populating temporary ponds although the lake was a deep, permanent lake with moderate water temperatures.--Auth.

2-2918. Darrah, William C. PRINCIPLES OF PALEOBOTANY: 2d ed., 295 p., 61 illus., map, chart, 12 tables, New York, Ronald Press, 1960, approx. 360 refs.

An introductory textbook combining a comparative phylogenetic and historical geological sequence of plant groups and floras. Emphasis is placed on classic work, but modern technical methods and new discoveries are discussed. The purpose is to acquaint the reader with the concepts and methods used by paleobotanists to interpret the fossil plant record. A feature of the book is the series of vegetation reconstructions drawn from many sources to visualize extinct plants. Chapters are included on coal paleobotany and pollen analysis. Among new techniques described are X-ray photography of fossils, transfer techniques, and a rapid peel method. --Auth.

Topics covered are: biological and geological principles; history and aims of paleobotany; paleobotanical techniques; early plant records: thallophytes; Psilopsida; other Devonian plants; Lycopsida; Sphenopsida; Pteropsida: ferns; pteridosperms; Carboniferous floras; the paleobotany of coals; Cordaitales and Ginkgoales; Bennettitales and Cycadales; Coniferales; Mesozoic floras; origin of the angiosperms; Upper Cretaceous floras; Cenozoic floras; origin of the existing flora; pollen analysis and floristics - keys to floral change; fossil plants and evolution; a reasonable phylogeny.

2-2919. Page, Virginia M. HOW TO IDENTIFY FOSSIL WOODS: Gems & Minerals, no. 270, p. 18-23, March 1960; no. 271, p. 24-31, Apr. 1960; no. 272, p. 23-27, May 1960; no. 273, p. 29-32, June 1960; no. 274, p. 23-28, July 1960; no. 275, p. 23-27, Aug. 1960; 22 illus., 5 diags., 10 refs.

A series of articles on the identification of fossil woods. The first article introduces the series by briefly outlining historical geology in connection with the distribution of fossil plants in North America. Practical difficulties attendant to identification are explained. The need for labeling specimens is pointed out, and a general classification of vascular plants is furnished along with classes within this category. The second article deals with the structure of wood and discusses tracheary elements, fibers, parenchyma, and classifications of each. The third article furnishes a guide to identification using a hand lens. The characteristics of gymnosperms, angiosperms, palms, and ferns are explained; prominent localities for representative material are mentioned. The fourth article deals with identification using a microscope, the equipment needed, the preferred types of microscopes, and the range of useful magnifications. Instructions are given for preparation of thin sections along with a list of equipment suppliers. The text portion of this series ends in this article with a key to some representative woods, in which prominent structural features are used as the basis for identification. The last 2 articles are photographs with associated explanatory texts.

Throughout the series, selected species showing cross sections, radial sections, and tangential sections of woods, along with magnifications used, are a prominent feature. Species include: Araucarioxylon, Pinus, Callixylon, Osmundites, Tempskya, Salix, Acer, Sequoia, Schilderia, Quercus, Lyonothamnus, Populus, Platanus, Magnolia, Dalbergia, and Trochodendron. Each photographed species is accompanied by brief concise summaries of the structural features which aid in recognition.--J. Sinkankas.

2-2920. Johnson, J. Harlan. PALEOZOIC SOLENOPORACEAE AND RELATED RED ALGAE: Colorado School Mines, Quart., v. 55, no. 3, 77 p., 65 illus. on 23 pls., 7 maps, chart, 7 tables, July 1960, 150 refs.

During the Paleozoic era, the calcareous red algae were represented by the family Solenoporaceae and by a few rather closely related forms. Members of the red algae appear in the fossil record during the Late Cambrian but were rare until late in the Ordovician. Probably an uncalcified, structurally quite similar ancestor developed considerably earlier.

Throughout the Paleozoic, the Solenoporaceae represented only a very minor element in the algal floras. Even though numerous specimens may be collected at certain stratigraphic levels over small geographical areas, they never were as abundant as their Mesozoic descendants nor as the coralline algae during the Cenozoic era.

By mid-Silurian times, 2 structurally distinct types of Solenoporaceae had differentiated - the Solenopora and the Parachaetetes. Among the Solenopora, the basic feature of the tissue is the vertical or radiating threads of cells with cross partitions at irregular intervals, while Parachaetetes is characterized by horizontal or concentric layers of cells.

During the Pennsylvanian period, several closely related forms, such as Archaeolithophyllum, Cuneiphycus, Ungdarella, and Komia, appeared. Whether they represent evolutionary developments or mutants from progressive members of the Solenoporaceae, or whether they arose from other red algae which only then developed the habit of calcification, we cannot say. Our knowledge of the upper Paleozoic algal floras is still too inadequate to answer this question. However, before the end of the Paleozoic era, we definitely can recognize the presence of forms which structurally forecast the appearance of the true coralline algae, including both the crustose and articulated types - types that did not become well established or abundant until toward the end of the Mesozoic era.--Auth. concl.

2-2921. Ross, Charles A. POPULATION STUDY OF CHAROPHYTE SPECIES, MORRISON FORMATION, COLORADO: Jour. Paleontology, v. 34, no. 4, p. 717-726, pl., 9 secs., diag., July 1960, 6 refs.

Populations of 8 species of charophyte gyrogonites from the Morrison formation (Jurassic), Front Range area, Colorado, collected in successive samples in 6 measured sections, show differences in average size, variation in size, and in tightness of spiralling. These differences, the same kind as are found among Recent charophyte subspecies, are suggestive of genetic changes resulting from evolution. The relative abundance of species in samples is apparently controlled by ecological conditions similar to those operative in distributing Recent Charophyta.

The proposed correlation of the 6 sections is based on population characteristics of the more abundant species, Aclistochara bransoni Peck, Praechara symmetrica Peck, and Latochara latitruncata (Peck). --Auth.

2-2922. Osgood, Richard G., Jr., and Alfred G. Fisher. STRUCTURE AND PRESERVATION OF MASTOPORA PYRIFORMIS, AN ORDOVICIAN DASYCLADACEAN ALGA: Jour. Paleontology, v. 34, no. 5, p. 896-902, 2 pls., secs., diag., Sept. 1960, 19 refs.

Mastopora pyriformis (Bassler), long known in American literature as Nidulites pyriformis, is a mid-Ordovician dasycladacean alga. Thin-section study of specimens from the Chambersburg limestone of Virginia has revealed new details of the cortical skeleton, traces of the central vesicle, and gametocysts. The skeleton was composed of aragonite, and was dissolved after burial. The calcite spar which preserves the shape of the cortical skeleton is a later precipitate in the space which remained between the external mold and partial, displaced internal calcilutite fillings.--Auth.

2-2923. Schofield, W.B., and H. Robinson. LATE-GLACIAL AND POSTGLACIAL PLANT MACROFOSSILS FROM GILLIS LAKE, RICHMOND COUNTY, NOVA SCOTIA: Am. Jour. Sci., v. 258, no. 7, p. 518-523, 29 figs., Summer 1960, 3 refs.

An analysis of plant macrofossils in a deposit from Gillis Lake is compared with the pollen analysis from the same deposit. The macrofossils belong to aquatic or lake-shore genera or to trees with windborne seeds. Zones containing a variety of macrofossils from aquatic plants and lacking those from lake-margin species in other zones are interpreted to reflect a drier climate. Of the 2 birch species represented, a larger number or exclusive presence of Betula lutea seeds suggests a milder climate, whereas a larger representation of B. papyrifera suggests cooler conditions. Using these criteria, the macrofossil record largely supports the conclusions made from the pollen analysis. The water milfoil Myriophyllum heterophyllum is identified from fossil seeds. This species is presumably extinct in the present flora of Nova Scotia.--Auth.

2-2924. Cahoon, Elizabeth J. SPHENOBAIERA IKORFATENSIS F. PAPILLATA FROM THE LAKOTA FORMATION OF THE BLACK HILLS: Torrey Bot. Club, Bull., v. 87, no. 4, p. 247-257, 17 figs., July-Aug. 1960, 23 refs.

Plant fossils from the basal rock unit of the Lakota formation of the Black Hills which Fontaine considered to be of Lower Cretaceous age were examined for epidermal structure. Only one species was found to possess a well preserved epidermis. On the basis of gross morphology and epidermal anatomy it was identified as Sphenobaiera ikorfatensis (Seward) Florin f. papillata Samylina. Previously, this ginkgophyte was known only from the Lower Cretaceous of western Greenland and the Upper Jurassic of Asiatic U.S.S.R.--Auth. summ.

2-2925. Prakash, U. A SURVEY OF THE DECCAN INTERTRAPPEAN FLORA OF INDIA: Jour. Paleontology, v. 34, no. 5, p. 1027-1040, map, table, Sept. 1960, 121 refs.

The Deccan Intertrappean flora, so far known, is summarized in the present paper. The flora is mostly silicified and often very well preserved, representing the groups Thallophyta (fungi, algae, and charophytes), water ferns, conifers, and angiosperms with both monocotyledons and dicotyledons. Although at this stage of knowledge of the Deccan flora, it is rather premature to say anything about the paleoecology, the author has tried to draw some tentative conclusions from the fossils so far obtained in the Intertrappean beds.

The age of the Deccan Intertrappean beds has been a controversial matter. It has been possible to give here in brief the various views so far expressed by a number of workers and the present official view of the Geological Survey of India, according to which the age of these beds ranges from uppermost Cretaceous to Eocene.--Auth.

2-2926. Gray, Jane. TEMPERATE POLLEN GENERA IN THE EOCENE (CLAIBORNE) FLORA, ALABAMA: Science, v. 132, no. 3430, p. 808-810, illus., table, Sept. 23, 1960, 9 refs.

Pollen, spores, hystrichospherids, dinoflagellates, and the fresh-water alga Pediastrum occur in marine clays at the classic Claiborne Bluffs locality, Alabama. The presence of Ephedra pollen provides the first documented Tertiary record of this genus from the southeastern states. The occurrence of several characteristically temperate genera lends support to the idea that a deciduous hardwood forest was present in the Appalachian uplands during the Eocene.--Auth.

2-2927. Davis, Margaret B. A LATE-GLACIAL POLLEN DIAGRAM FROM TAUNTON, MASSACHUSETTS: Torrey Bot. Club, Bull., v. 87, no. 4, p. 258-270, map, 2 diags., table, July-Aug. 1960, 16 refs.

Pollen analyses of sediments from 2.55-5.20 m. depth in a bog near Taunton, in southeastern Massachusetts, are presented in a pollen diagram. The pollen sequence in the organic sediments includes the Lower Durham Spruce pollen zone (A-1-2-3), deposited during the Two Creeks interval, the Upper Durham Spruce zone (A-4), deposited during the subsequent Valders time, and the Lower and Upper Pine zones (B-1 and B-2). The overlying peat was not analyzed. The underlying highly inorganic sediments, which are contaminated with secondary pollen, are apparently stratigraphically equivalent to the Herb pollen zone (T or T-3) at other sites.

The pollen diagram differs from others in that the ratio of spruce to pine pollen in zones A-1-2-3 and A-4 is lower than at Petersham and Athol, and higher than at sites nearer the coast. Spruce pollen percentages do not reach a maximum early in the spruce pollen zone, as at some other sites, but increase throughout zone A-1-2-3. Oak pollen percentages in zone A-1-2-3 are higher than recorded at other sites.

There is no evidence that a vegetational or climatic oscillation prior to the Two Creeks interval occurred after deposition of the sediments began.--Auth. summ.

2-2928. Pestana, Harold R. FOSSILS FROM THE JOHNSON SPRING FORMATION, MIDDLE ORDOVICIAN, INDEPENDENCE QUADRANGLE, CALIFORNIA: Jour. Paleontology, v. 34, no. 5, p. 862-873, 4 pls., map, Sept. 1960, 24 refs.

Interbedded Middle Ordovician quartzite and carbonate rocks of the Independence Quadrangle, Inyo Mountains, are here named the Johnson Spring formation. Correlation with the Eureka quartzite of the Great Basin is based on lithologic similarity and stratigraphic position. The carbonate rocks of the Johnson Spring formation contain a large fauna in which corals are predominent. New species are Anthaspidella inyoensis (sponge); Streptelasma tennysoni, Paleophyllum mazourkensis, Grewingkia whitei, Brachyelasma bassleri, Lichenaria sisyphi, Eofletcheria kearsargensis, (corals); Ptychopleurella arthuri, (brachiopod). These and other fossils occurring in the Johnson Spring formation indicate a Trentonian(?) age.--Auth.

2-2929. Perry, T.G. FOSSILS: PREHISTORIC ANIMALS IN HOOSIER ROCKS: Indiana, Geol. Survey, Circ. 7, 83 p., 19 figs., 1959.

Many Hoosiers collect fossils, stony remnants of prehistoric life, as they are common and attractive objects in the rocks of Indiana. This handbook was prepared to stimulate interest in fossil collecting and to acquaint collectors with the characteristics of the major kinds of fossils that may be found in Indiana's rocks. In addition, the uses of fossils, their role in demonstrating the doctrine of organic evolution, their classification, and other kindred topics are discussed in a nontechnical manner. Scientific terms are defined simply, and locations of some excellent fossil-collecting sites in Indiana are given. Most of the illustrations are of fossils that collectors may find in Hoosier rocks. This handbook should appeal especially to high school students interested in earth science and to their teachers, to the seasoned collector, and to the person desirous of pursuing an inexpensive out-of-doors hobby.--Auth.

2-2930. Bates, John D., and George Biemesderfer. STRATIGRAPHY AND PALEONTOLOGY OF AN OCCURRENCE OF DIATOMACEOUS EARTH IN NEBRASKA: Jour. Paleontology, v. 34, no. 4, p. 759-761, map, July 1960, 6 refs.

A layer of diatomaceous earth, 2 to 3 ft. thick, is reported in the Mullen Dam and Reservoir site, Hooker and Cherry counties, Nebraska. Impurities are 1% or less of quartz grains and black organic matter. Most of the diatoms are Naviculineae. A tentative identification of the snail Gyraulus labiatus indicates Yarmouth interglacial age.--M. Russell.

2-2931. Williams, E.G. MARINE AND FRESH WATER FOSSILIFEROUS BEDS IN THE POTTSVILLE AND ALLEGHENY GROUPS OF WESTERN PENNSYLVANIA: Jour. Paleontology, v. 34, no. 5, p. 908-922, pl., 6 maps, sec., diag., 2 tables, Sept. 1960, 29 refs.

Stratigraphic and paleontologic studies of the Pottsville and Allegheny groups [Pennsylvanian] of western Pennsylvania have resulted in the establishment of 12 environmental, faunal zones, some of which have proved useful in regional correlation and paleographic interpretations.

Marine and restricted marine fossils, mainly Chonetes, Mesolobus, Marginifera, Lingula, Dunbarella, and Aviculopecten occur in dark-gray shales above the upper Mercer, lower Clarion, upper Clarion, Scrubgrass, lower and middle Kittanning coals. Fresh-water fossils, mainly estherids and Carbonicola are found in shales above the upper Kittanning, and lower and upper Freeport coals, and ostracods and small gastropods are found in the limestones below these coals.

The most rapid faunal variation in all marine beds takes place in a general N.-S. direction. The marine fossils disappear to the N. and E. in the upper Mercer and lower Clarion shales, whereas they disappear to the NW. and SE. in the other beds.--Auth.

2-2932. Richards, Horace G., and Arthur H. Hopkins. OLIGOCENE FOSSILS FROM THE OLD BOLTON PHOSPHATE MINE NEAR CHARLESTON, SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 3, p. 19-24, 2 pls., May-June 1960, 6 refs.

Fossils are described from material collected during 1957 and 1958 from spoil banks of the old Bolton phosphate mine, 9 mi. SW. of Charleston. The material on the spoil banks included an arenaceous limestone (Cooper marl, Oligocene) and phosphate nodules of the overlying Ladson formation (Pleistocene).

The phosphate nodules were jagged and very irregular in outline and varied in color from light to dark brown, bluish and nearly white, and nearly white to nearly black. They were characterized by abundant casts and molds of fossils, the original shell material having been dissolved.

The arenaceous limestone (Cooper marl) contained both altered and unaltered shells, some of which were the same species as those in the phosphate nodules. Some of the unaltered shells probably represent contamination from a superficial Pleistocene layer.

Scattered over the spoil banks were various vertebrate fossils including shark teeth, fish vertebrae, ray dental plates, and miscellaneous bone fragments. --H.S. Johnson, Jr.

2-2933. Hoare, Richard D., and J.D. Burgess. FAUNA FROM THE TENSLEEP SANDSTONE IN WYOMING: Jour. Paleontology, v. 34, no. 4, p. 711-716, pl., July 1960, 14 refs.

New collections from the Tensleep sandstone in the Wind River basin and Big Horn basin of Wyoming contain 9 species of brachiopods, 1 scaphopod, 1 gastropod, and 1 trilobite. All specimens are either referable to previously described species or are impossible to identify specifically. This fauna strengthens the conclusion that the Tensleep sandstone in this region is Des Moinesian [Pennsylvanian] in age.--Auth.

2-2934. Lochman-Balk, Christina, and Chung-Hung Hu. UPPER CAMBRIAN FAUNAS FROM THE

NORTHWEST WIND RIVER MOUNTAINS, WYOMING. PART I: Jour. Paleontology, v. 34, no. 5, p. 793-834, 6 pls., 2 maps, 2 secs., Sept. 1960, 46 refs.

Dresbachian and early Franconian faunas from 2 measured sections near Green River Lakes in the northwestern Wind River Mountains, Wyoming, are described in several papers. Pt. 1 gives the stratigraphy of the sections and describes and discusses the assemblages from the Conaspis, Elvinia, Aphelaspis, and Crepicephalus zones, the agnostids and brachiopods from the Cedaria zone and several trilobites of Middle Cambrian age. The larger trilobite assemblages of the Cedaria zone will be described in subsequent papers.

Faunules from the Conaspis zone contain 5 genera and species of brachiopods and 4 of trilobites. Within the Eoorthis subzone Eoorthis beds are developed locally, the first reported occurrence of the feature in the Cordilleran region. The base of the Billingsella subzone is also present, but all higher Cambrian strata have been eroded. A characteristic Camaraspis subzone faunule of 10 genera and species of trilobites and 2 of brachiopods represent the Elvinia zone. The species of the Franconian faunas are all previously described forms from either the central Interior or the Cordilleran region.

The Open Door formation and the underlying DuNoir limestone are separated by a prominent disconformity which spans at least all of Dunderbergia zone time and early Elvinia zone time, when the area was emergent and undergoing erosion. In the Clear Creek section most of the Aphelaspis zone strata were removed. In the Sheep Mountain section 175 ft. or more of strata, comprising the entire Aphelaspis and Crepicephalus zones and the upper third of the Cedaria zone, are missing.

The Aphelaspis faunule is known from 2 trilobite genera and species and the gastropod, Hypseloconus, collected from the top DuNoir bed in the Clear Creek section. Two faunules represent the Crepicephalus zone. A small faunule obtained a few inches below the Aphelaspis assemblage contains 3 genera and species of trilobites and 1 brachiopod. A larger faunule at the base of the zone contains 1 gastropod, 3 brachiopod, and 6 trilobite species, including Minicephalus primus, a new genus and species. The form may be the ancestral stock of the Lecanopygidae.

The Cedaria zone assemblage contains calcareous algae, 5 genera and species of brachiopods, 2 genera and species of gastropods?, Semicircularea and Hyolithes, 2 different and stratigraphically significant forms of Eocrinoidea, a new species of Conchostracean, Dielymella? trituberculata, and 27 genera and at least 54 species of trilobites. Two species of agnostid, 1 new - Baltagnostus wyomingensis, and the proparian, Holcacephalus tenerus, are described. H. tenerus ranges through 95 ft. of section and is considered a stable species indigenous to the Utah-Wyoming area.

Two small collections of late Middle Cambrian fossils are included. They represent 2 different horizons within the uppermost unnamed Middle Cambrian faunal zone. The highest faunule contains 2 trilobite genera and is referred to as the Olenoides subzone. The lower faunule contains 3 trilobite genera, including 1 new species and 2 new genera - Josina festiva in the Menomoniidae and Americare tetonensis (Resser) in the Anomocaridae. Additional material of Ithyektyphus tetonensis (Miller) suggests a close relation with Modocia. The horizon is referred to as the Americare subzone.--Auth.

2-2935. Jelinek, Arthur J. A LATE PLEISTOCENE VERTEBRATE FAUNA FROM TEXAS: Jour. Paleontology, v. 34, no. 5, p. 933-939, 3 illus. on pl., diag., 5 tables, Sept. 1960, 23 refs.

A Pleistocene fauna from the Foley gravel pits on a low terrace of the Wichita River near Wichita Falls, Texas, is discussed and assigned to the time of the Wisconsin glaciation. The fauna includes: Lepisosteus? sp., Cynomys ludovicianus (Ord), Geomys cf. bursarius (Shaw), Sylvilagus cf. audubonii (Baird), Taxidea taxus (Schreber), Mammuthus sp., Camelops hesternus (Leidy), Bison (Platycerobison) chaneyi Cook, Equus cf. leidyi Hay. The fauna is similar to the Berclair terrace fauna of S.-central Texas and indicates a somewhat dryer climate than is now present in the Wichita Falls area.--Auth.

6. GEOPHYSICS

See also: Geologic Maps 2-2779 through 2-2798; Geomorphology 2-2825; Structural Geology 2-2846, 2-2848; Engineering Geology 2-3118, 2-3119, 2-3121, 2-3122.

2-2936. Runcorn, S.K., ed. METHODS AND TECHNIQUES IN GEOPHYSICS. VOLUME 1: 374 p., illus., diags., graphs, tables, New York, Interscience Publishers, 1960, refs.

Although much material has been published dealing with observational data in pure geophysics and the theories developed about the interior of the earth, no comparable literature seems to exist concerning the modern advances in physical techniques in this subject, which have made possible much of the developments in pure geophysical research. This book attempts to repair this deficiency. Geophysics is taken to include only the physics of the solid state, and no mention is made of techniques designed mainly to throw light on the physical processes in the oceans, atmosphere, and high atmosphere.--From auth. pref.

The following papers are included in the volume:

Bullard, E.C. Measurement of Temperature Gradient in the Earth, p. 1-9.

Misener, A.D., and A.E. Beck. The Measurement of Heat Flow Over Land, p. 10-61.

Gaskell, T.F., and P. Threadgold. Borehole Surveying, p. 62-103.

Whitham, K. Measurement of the Geomagnetic Elements, p. 104-167.

Collinson, D.W., and K.M. Creer. Measurements in Palaeomagnetism, p. 168-210.

Harrison, J.C. The Measurement of Gravity at Sea, p. 211-229.

Willmore, P.L. The Detection of Earth Movements, p. 230-276.

Garland, G.D. Earth Currents, p. 277-307.

Hughes, D.S. Properties of Rocks Under High Pressure and Temperature, p. 308-324.

Markowitz, W. Latitude and Longitude, and the Secular Motion of the Pole, p. 325-361.

2-2937. Cohen, Charles J., and Richard J. Anderle. VERIFICATION OF EARTH'S "PEAR SHAPE" GRAVITATIONAL HARMONIC: Science, v. 132, no. 3430, p. 807-808, diag., table, Sept. 23, 1960, 4 refs.

Predictions of the orbit of the Transit 1B satellite were systematically in error until account was taken of a third-order gravitational harmonic. The amplitude deduced for this harmonic by O'Keefe from the Vanguard I orbit serves very well, even though the orbits and the methods of observation and orbit fitting for the 2 satellites are quite different.--Auth.

2-2938. Veis, George. GEODETIC USES OF ARTIFICIAL SATELLITES: Smithsonian Inst., Smithsonian Contr. Astrophysics, v. 3, no. 9, p. 95-161, 23 figs., 1960, 63 refs.

The geodetic methods heretofore applied to the data provided by the artificial satellites have been based on a dynamic approach. That is, the perturbations in the motion of a satellite have been used to determine the gravitational field of the earth and thus to obtain information on the shape of the geoid. This paper presents another way of using the satellites in geodesy. The methods depend on a geometric approach which consists of performing a triangulation in space and determining the positions of a certain number of observing stations whose positions are unknown. These methods have the advantage that they use a unique system of reference direction which is not affected by the earth's gravitational field (or the geoid), and that the errors from refraction are reduced to a minimum. The mathematical tools are fairly simple, consisting mainly of analytical geometry in 3 dimensions. In principle, the method involves performing a 3-dimensional space triangulation, with the observed objects (satellites) and the observing stations on the earth as the vertices. On this triangulation net are computed the positions of the stations. Although the methods presented were devised specifically for use with the artificial satellites, they can be applied, with some modifications, to such targets as the moon, rockets, and even to terrestrial objects.--From auth. introd.

2-2939. Lozinskaya, A.M. THE STRING GRAVIMETER FOR THE MEASUREMENT OF THE GRAVITY AT SEA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 3, p. 272-278, 6 diags., pub. May 1960, 6 refs.

The principle and method of construction of a working model of a string gravimeter with automatic recording of the frequency of vibration of the string is described. This model was designed in the All-Union Institute of Scientific Research in Geophysical Methods of Prospecting of the Ministry of Geology and the Conservation of Mineral Resources for gravimetric surveys at sea.--Auth.

2-2940. Dimitrov, L.V. GRAPHICAL METHOD OF CALCULATING THE VALUES OF THE SECOND VERTICAL DERIVATIVE OF THE GRAVITY POTENTIAL: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 4, p. 432-434, 3 figs., pub. May 1960, 3 refs.

A graphic method of evaluating the second vertical derivative of gravity, U_{zz}, is suggested. The procedure is explained and illustrated by several figures and lengthy computations.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-203).

2-2941. Raspopov, O.M. THE VERTICAL GRADIENT OF THE FORCE OF GRAVITY IN MOUNTAINOUS REGIONS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 886-888, 2 profiles, graph, table, pub. July 1960, 3 refs.

Gravity anomalies Δg and the gravity gradient $\Delta\theta$ were measured at 38 stations, located at different heights from deep in a valley to the highest ridges of the Caucasus. As expected, the lowest values of Δg were found on the tops of ridges; $\Delta\theta$ was computed using Numerov's formula. Geographic coordinates of the stations, measured values of Δg, and computed values of $\Delta\theta$ are given in a table. It is concluded that the field of the vertical gradient of gravity is determined primarily by near-surface masses.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-205).

2-2942. Russell, R.D., J.A. Jacobs, and F.S. Grant. GRAVITY MEASUREMENTS ON THE SALMON GLACIER AND ADJOINING SNOW FIELD, BRITISH COLUMBIA, CANADA: Geol. Soc. America, Bull., v. 71, no. 8, p. 1223-1230, illus., fold. map, 3 profiles, diag., Aug. 1960, 3 refs.

An account is given of a detailed gravity survey carried out on the Salmon Glacier and the adjoining snow field. The reduction of the data is complicated by the extreme irregularity of the terrain and by the fact that the structure of the glacier and the locations of the stations are time dependent. Maps show the Bouguer anomalies, and 2 profiles are drawn across the glacier and 1 along its length. The accuracy of the results is discussed in detail; it is concluded that gravity measurements alone can give a very good indication of the shape of a deep-valley glacier and also its approximate depth. Other independent data are necessary to determine its precise thickness.--Auth.

2-2943. Lyustikh, E.N. ISOSTASY AND ISOSTATIC HYPOTHESES: Am. Geophys. Union, Soviet Research in Geophysics, in English translation, v. 2, 119 p., 33 figs. incl. 5 maps (in pocket), secs., diags., graphs, 4 tables, New York, Consultants Bureau [1960], 69 refs.

Originally published as Izostaziya i Izostaticheskie Gipotezy, Akademiya Nauk SSSR, Geofizicheskii Institut, Trudy no. 38 (165), Moscow, 1957.

This volume discusses the problem facing physicists and others in determining the Earth's shape by isostasy. The classic theories of Airy, Pratt, Dutton, and others are discussed, criticised, and amplified in the light of new data. The methods of gathering this information, the means of analysis and the application of original Soviet research are expounded fully, both in the text and on related maps. Theories related to isostatic rebound, compensation and overcompensation, gravitational anomalies showing concentrations of density, etc., are illustrated with accompanying pertinent data. The papers contained in this book were designed to produce a clearer and more up-to-date picture of the Earth, based on isostasy.--Consultants Bureau.

The 9 chapters cover the following subjects: principles of isostatic theory; methods of studying isostasy; influence of geologic processes on isostasy (theory); isostatic hypotheses; isostatic status of the earth; causes of zonal anomalies; compensation and overcompensation; errors in the analysis of isostatic anomalies; "emergence" of Fennoscandia; role of isostasy in geotectonics.

2-2944. Pertsev, B.P. THE CALCULATION OF ZERO POINT DRIFT DURING OBSERVATIONS ON

ELASTIC TIDES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 4, p. 376-377, pub. May 1960, 3 refs.

A modification of Doodson's method for eliminating instrument zero drift during observations on tidal deformations of the earth.--Auth.

2-2945. Rotstein, A. Ya., and V.S. Zierel. SOME RESULTS OF EXPERIMENTS CONDUCTED WITH A NUCLEAR MAGNETOMETER: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 7, p. 763-765, 3 figs. incl. illus., pub. July 1960, 5 refs.

A description is given of the absolute nuclear precession magnetometer AYaPM-4-VITR designed and built in the U.S.S.R. This instrument operates on the principle of nuclear resonance and is designed for field use. It measures the absolute value of the total magnetic vector T with an accuracy of $\pm 2 \lambda$. The time of 1 measurement is 2 sec., and measurements can be made every 10 sec. The total weight of the magnetometer, with a battery good for 1,000 measurements, is only 8.5 kg. The instrument consists of the following parts: an emitter, an electronic device, and a recorder. The emitter is a cylindrical glass container filled with a mixture of water and alcohol. The electronic device contains a set of standard quartz resonators, an amplifier, a divide detector, a filter, and an amplifier at the outlet. A storage battery and dry batteries are used. The characteristic curves of the instrument, obtained in field measurements, are reproduced. The magnetometer has been used in several parts of the U.S.S.R. with fully satisfactory results.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-329).

2-2946. Petrova, G.N., and T.A. Ismailzade. THE USE OF STABILITY PARAMETERS FOR THE DETAILED CORRELATION OF PROFILES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 3, p. 260-271, 17 figs. incl. illus., diags., profiles, pub. May 1960, 4 refs.

It is shown that the cutoff field H'_c is a possible parameter for correlation of layers of sedimentary rock. Changes in H'_c with depth indicate the stratification of the deposits. A mineralogical analysis showed that, in contrast to the magnetic susceptibility κ and the remanent magnetization I_n, H'_c depends not on the concentration of ferromagnetic materials, but rather on the nature of the ferromagnetic material of which the rocks are composed, and on the size of the grains.--Auth.

2-2947. Berdichevsky, M.N., and B.E. Brunelli. THEORETICAL PREMISES OF MAGNETO-TELLURIC PROFILING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 7, p. 757-762, 5 figs., pub. July 1960, 6 refs.

The relationships between the electric and magnetic components of a plane-monochromatic wave in horizontally-homogeneous media are analyzed for horizontal and for inclined layers. These relationships are considered as the first step leading to a new method of geophysical exploration, namely, the method of magnetotelluric profiling (MTP). MTP method is considered to be superior to the telluric-current method (MTC) because it eliminates the necessity of simultaneous observation of the electromagnetic field at 2 different points of the area surveyed, and because there is no need for a base-station network in regional investigations. These 2 factors make the MTP method more economical. The data processing is also simpler. From the measured values it is possible to determine the absolute value of the total longitudinal conductivity, not relative resistivity as in the case of the MTC method. A theoretical study is presented based on Maxwell's fundamental equations of the ratio between the electric and magnetic components of the electromagnetic field. Special cases examined in the article are a homogeneous half-space and a 2-layer profile.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-153).

2-2948. Taychinov, R.S. THE CURIE POINT OF ROCKS WITH LOW FERROMAGNETIC CONTENT: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 6, p. 636-641, 13 diags., pub. June 1960, 7 refs.

A method is suggested and described in detail for determining the Curie point of the ferromagnetic fraction of weakly magnetic rocks by means of the temperature at the point of inflexion on the curve $1/\chi = f(T)$. This is the consequence of the fact that in rocks the difference between the Curie points of the paramagnetic and ferromagnetic fractions $\theta_p - \theta_x$ is very small. It is shown that the usual procedure is not always accurate due to the presence in natural rocks of a significant ferromagnetic fraction.

The Curie point has been determined for several weakly magnetic rocks, such as siltstone, shale, and red sandstone. Some types of siltstone may possess paramagnetic properties. The Curie temperature determined on different volumes of specimens of magnetic quartzite can differ by as much as 15°C.; this is explained by heterogeneity in distribution of ferromagnetic substance throughout the mass. This phenomenon was especially marked in rocks containing TiO_2. Ferromagnetic components of some of the rocks investigated showed phase transformations when undergoing temperature variation. It is possible to state that the sedimentary rocks are more homogeneous than the eruptive rocks. For sedimentary rocks the Curie point is a good characteristic for determining the nature of the ferromagnetic component.--S.T. Vesselowsky (courtesy Geophysical Abstracts 178-286).

2-2949. Petrova, G.N., and V.A. Koroleva. DETERMINATION OF THE MAGNETIC STABILITY OF ROCKS UNDER LABORATORY CONDITIONS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 5, p. 493-497, 4 diags., 2 tables, pub. June 1960, 5 refs.

This paper points out the necessity of determining the vectorial stability of remanent magnetization in rocks in the utilization of these data for the determination of the pole position during the various geologic periods. It describes briefly a method for stability determination under actual and laboratory conditions, and gives the theoretical premises for determining the degree of the magnetic stability according to Neel's theory. The experimental results of testing the magnetic stability of Siberian trap rocks in constant and alternating fields are described. Their analysis shows that such a stability is a more consistent characteristic of the rock than the vector of remanent magnetization.--Auth.

2-2950. Gregory, A.F., and others. GEOLOGICAL INTERPRETATION OF AEROMAGNETIC PROFILES

FROM THE CANADIAN ARCTIC ARCHIPELAGO: Canada, Geol. Survey, Paper 60-6, 13 p., 3 maps, 2 graphs, 1960, 7 refs.

Airborne geophysical surveys covering 9.000 mi. of widely spaced profiles were flown at 800 ft. in a cobweb pattern centered on Resolute Bay, Cornwallis Island. The regional interpretation of these geophysical data substantiates the general geological structures recognized by field geologists and provides additional detail. Thus the Boothia arch appears to be an imperfectly developed horst extending at depth as far N. as the SE. corner of Bathurst Island. Related basement uplifts may underlie the southern portion of the Cornwallis fold belt. Several of the lower Paleozoic basins may occupy, in part, graben or fault block structures. Maximum depths to basement in these basins are greater than 10,000 ft. A W.-trending regional fault in Lancaster Sound appears to parallel the S. coast of Devon Island and may offset the northern end of the Boothia arch. The Paleozoic fold belts appear to be devoid of widespread igneous intrusions although scattered dikelike anomalies suggest that small basic plutons occur more frequently than is presently known. The magnetic data from the Sverdrup basin suggest that igneous dike activity and extensive folding occur only within the eastern half of this basin, although thin sheets of basic rock are probably present in much of the western half. A structural complex similar to the Parry Islands and central Ellesmere fold belts may bound the basin on its NW. side.

Magnetic anomalies, which in profile show a central minimum with marginal maxima, are characteristic of known gypsum domes in this area. Variform magnetic expressions result from sills in the strata which are variously upturned by intrusion of the domes.

It is concluded that aeromagnetic surveys will provide data useful for the geological study of this region.--P. Harker.

2-2951. Washington, Division of Mines and Geology. GEOLOGICAL INTERPRETATION OF AIRBORNE MAGNETOMETER AND SCINTILLOMETER SURVEY, MT. BONAPARTE, BODIE MOUNTAIN, CURLEW, AENEAS, AND REPUBLIC QUADRANGLES, OKANOGAN AND FERRY COUNTIES, WASHINGTON. Prepared by Hunting Geophysical Services, Inc.: Its: Rept. Inv. no. 20, 34 p., 5 map sheets, 20 overlay sheets (under separate cover), map, graph, 1960, approx. 100 refs.

The survey was conducted between Sept. 25 and Oct. 30, 1959. Flight direction was E.-W., lines were flown with an interval of 1,320 ft., and the average ground clearance was 500 ft. A total of 3,945 line miles was surveyed. "The survey area is part of the Okanogan Highlands physiographic province. It is characterized by N.-S. lowland areas of considerable depth alternating with equally prominent N.-S. uplands mostly lacking in marked continuity. The province has a relief of well over 7,000 ft. but shows little of the roughness which might be expected."

A general statement made concerning the general geology of the Republic mining district is essentially appropriate for the entire area. Major features are "sedimentation in the Paleozoic, erosion with minor vulcanism in the Mesozoic, igneous activity and erosion in the Tertiary, and continental glaciation in the Quaternary." Metamorphic rocks and ore deposits are discussed separately.

The radiometric survey is outlined and briefly evaluated. The magnetic survey is described, and separate geologic interpretations are given for each quadrangle. A set of maps, consisting of a map and 4 overlay sheets, for each quadrangle accompanies the report.--L.M. Dane.

2-2952. Du Bois, P.M. CORRELATION OF KEWEENAWAN ROCKS OF LAKE SUPERIOR DISTRICT BY PALAEOMAGNETIC METHODS: Geol. Assoc. Canada, Proc., v. 11, p. 115-128, 8 figs. incl. map, diags., Dec. 1959, 17 refs.

The positions of the earth's magnetic poles have changed during geological history. As a result, the local magnetic field, which determines the direction of the remanent magnetic moment of a rock, when it is formed, changes with time. These changes mean that rocks which acquired similar stable remanent moments at the time of their formation are very likely the same age, while other rocks which have remanent moments different from one another were not formed at the same time. Using this principle, the author attempts in this paper to show the contemporaneity or noncontemporaneity of certain Keweenawan rocks from the Lake Superior district. The paleomagnetic interpretations are in general agreement with the geological deductions.--Auth.

2-2953. Komarov, A.G. PALEOMAGNETIC INVESTIGATIONS OF LOWER PALEOZOIC BASALTS OF THE UKRAINE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 877-882, 3 diags., graph, 4 tables, pub. July 1960, 9 refs.

As a result of paleomagnetic investigations of Volyn basalts, the author established the position of the geomagnetic pole in the lower Paleozoic period according to the direction of vector I_n in magmatic rocks, for which their absolute age is known.

The unusual orientation of the I_n-vectors for certain magmatic rocks of the Ukraine is explained from the viewpoint of the hypothesis of migration of the geomagnetic poles and of the inversion of the geomagnetic field in fixed time periods of geological history.

A consideration of the hypothetical drift of continents leads to an almost complete coincidence of the position of the poles, calculated on the basis of paleomagnetic data of 2 regions separated one from the other.

The superposition of inductive and residual magnetization of various directions, which occurs for the rocks studied, makes a real question out of the need of considering such a type of heterogeneities of magnetization in the mathematical methods of interpreting magneto-prospecting observations.

The good coincidence of the geomagnetic latitudes of various periods of geological history with paleoclimatic indicators demonstrates that the variation in the earth's magnetic field, being revealed with the aid of paleomagnetic investigations of rocks, is obviously connected with the wandering of the geographic poles, i.e., with a change in the inclination of the earth's axis. In its turn, such a close connection between the magnetic axis and the earth's axis of rotation testifies to the great significance of the rotational effect in the origin of the over-all magnetic field of the earth.--Auth.

2-2954. Guskova, E.G. PALEOMAGNETIC STUDIES OF SEDIMENTARY ROCKS OF SOUTH EASTERN TURKMENIA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 3, p. 311-314, 4 figs., 2 tables, pub. May 1960, 4 refs.

Two hundred oriented samples from 5 natural outcrops, considered by geologists as belonging to the Paleogenic and Neogenic periods, were studied. The total length of all 5 cross sections attained 1,500 m. The useful length from which the selection of samples was possible from a practical standpoint was 1,000 m. On the average one sample was selected every 5-7 m. along the outcrop. The layers of cross sections were not always horizontal. This necessitated using complex corrections to compensate for the slope of the layers under study.

The authors consider that the concurrence of coordinates of the geomagnetic pole, computed independently by separate authors on corresponding groups of samples cannot be a simple coincidence and that the results of this study confirm again the fact that geomagnetic poles were displaced in the geological past and that the magnetic axis turned by 180°.--From auth.

2-2955. Ivakin, B.N. MODELING OF SOME GEOPHYSICAL PHENOMENA ON ELECTRICAL GRIDS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 5, p. 480-485, 2 diags., pub. June 1960, 18 refs.

The author discusses possibilities of modeling nonlinear processes occurring in earthquake foci and in the vicinity of explosions (phenomena of continuity disruption of an elastic medium), as well as the wave phenomena associated with such processes, by means of electrical grid models. He also investigates possibilities of modeling electromagnetic waves propagating in a conductive medium by means of an electrical grid model. A model is found which reproduces the "scalar process" of electromagnetic wave propagation.--Auth.

2-2956. Blokh, I.M., and E.A. Shemyakin. CONSTRUCTION OF DIPOLE AND THREE ELECTRODE ELECTROPROFILING CHARTS FROM INVESTIGATIONS OF STRAIGHT-LINE UNSYMMETRIC BAMN SYSTEMS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 6, p. 614-619, 4 figs., pub. June 1960, 4 refs.

With the rectilinear asymmetrical electrode arrangement BAMN, it is possible to obtain graphs of either dipole or 3-electrode profiling, depending on the properties of the geoelectric profile and the dimensions of the entire installation. In the case of a profile characterized by an increase of apparent resistivity with increasing electrode separation, graphs of 3-electrode profiling can be obtained with smaller ratio of l_2/l_1 (here l_1=AO; l_2=A^1O). The graphs of 3-electrode profiling can be obtained with shorter distance of the current electrode from the potential electrodes MN. With increasing distance between MN electrodes it is possible to construct graphs of the 3-electrode profiling with a smaller l_2/l_1 ratio.--S.T. Vesselowsky (courtesy Geophysical Abstracts 178-111).

2-2957. Tikhonov, A.N., and others. THE DISTINGUISHING OF EQUIVALENT EARTH SECTIONS BY MEANS OF ALTERNATING ELECTROMAGNETIC FIELDS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 861-863, 7 figs., pub. July 1960, 5 refs.

A method of vertical electric profiling with direct current fails to distinguish different layers in the case of equivalent sections. (Equivalent cross sections are those satisfying the relationship $\frac{h_1}{\rho_1} + \frac{h_2}{\rho_2} =$ constant, where h_1 and h_2 are the layer thicknesses, and ρ_1 and ρ_2 their resistivities.) Theoretical analysis and experiments show that by using alternating electromagnetic fields it is possible to obtain clearly distinguishable curves, using either the electrical or the magnetic component of the field. The curves in question are reproduced in the article.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-146).

2-2958. Dmitriev, V.I. THE EFFECT OF INHOMOGENEITIES IN THE EARTH ON THE FIELD OF A RECTILINEAR, INFINITELY LONG CABLE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 4, p. 435-437, 3 figs., pub. May 1960, 2 refs.

The effect of a perfectly conducting thin vertical vein of finite depth on the electromagnetic field of an infinitely long cable laid on an otherwise homogeneous ground is analyzed mathematically. The results show that for shallow veins, the modulus anomaly is of the order of some tens of percents, and the phase anomaly some tens of degrees. Away from the vein the anomaly dies out rapidly, the modulus anomaly more rapidly than the phase anomaly. On the average, the width of the anomaly is of the order of 0.1-0.2 of the wavelength in the ground. With increasing depth the intensity of the anomaly decreases but its width increases.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-145).

2-2959. Belotelov, V.L., N.V. Veshnyakov, and I.I. Zhilyaev. A SEISMIC ENERGOMETER: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 4, p. 427-431, 6 figs., pub. May 1960, 9 refs.

A new type of instrument developed by Belotelov and his associates for the purpose of measuring earthquake energy. It consists of 3 independent elements: a velocimeter, a functional converter, and an integrator. The velocimeter has 1 vertical and 2 horizontal seismographs. The seismographs are strongly damped. Their coefficient of damping $\underline{D}$ must satisfy the conditions $\underline{D} \geq \frac{1}{\sqrt{8\delta}} \left(\sqrt{\frac{T_{p\,max}}{T_{p\,min}}} - \sqrt{\frac{T_{p\,min}}{T_{p\,max}}} \right)$; here $T_{p\,min}$ is the shortest period and $T_{p\,max}$ is the greatest period of the seismic waves, and δ is the admissible error. An example illustrating the operation of the energometer is given, and the results are compared with similar calculations for a seismogram.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-108).

2-2960. Brunelli, B.E., and V.V. Alekseev. SEISMOGRAPH SYSTEM WITH FEEDBACK: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 5, p. 524-527, 2 diags., pub. June 1960.

A system consisting of a seismic receiver and an amplifier containing elements of a negative reverse coupling (called a negative feed back in radio) is investigated. Theoretical and experimental investigations of this system show the possibility of transforming a seismic receiver into an instrument for measuring acceleration. Such an accelerometer has a wide range of frequencies. In the experiments described, frequencies from 6 to 300 cycles per second [c.p.s.] could be measured. This range can be further extended to 1 c.p.s. A great advantage of the system is the linearity of its recording over a wide nge of frequency; this is achieved by increasing e damping of the instrument. The proposed system eceiver and amplifier) can be used not only in build- g seismic receivers but also in many other branches geophysics and in engineering.--S.T. Vesselow- y (courtesy Geophysical Abstracts 181-143).

-2961. Glivenko, E.V. DETERMINING A MAG- ITUDE BY EXCESS OBSERVATIONS IN SEISMO- OGICAL PROBLEMS: Akad. Nauk SSSR, Izves- ya, Geophysics Ser., in translation, 1959, no. 7, 696-700, 2 figs., pub. July 1960, 6 refs.

A statistical treatment of seismic observations. method of determining the most probable value of unknown quantity with an excess number of obser- ations is described. Such quantities might be: the ypocenter of an earthquake, the energy of an earth- ake, the dynamic parameters of a focus, and others hen, in determining these quantities, we use records om several stations. The method proposed here is ased on examining the probability function. The uestion of finding the most probable hypocenter of n earthquake is discussed in detail.--Auth.

-2962. Glivenko, E.V. ON THE EVALUATION F ACCURACY IN THE DETERMINATION OF THE YPOCENTERS OF EARTHQUAKES: Akad. Nauk SSR, Izvestiya, Geophysics Ser., in translation, 959, no. 4, p. 363-368, 3 diags., pub. May 1960, refs.

The paper examines the probability method of valuation. It is assumed in this case that an error the determination of the location of the focus de- ends solely upon inaccuracies in time readings, but oes not depend on the indeterminable inhomogeneity the medium. The evaluation of accuracy is made the method of construction of the function of error istribution. Some specific cases of the determina- on of the hypocenter of an earthquake by the methods Wadati and Ishikawa are analyzed.--Auth.

-2963. Tamrazyan, G.P. INTERMEDIATE AND EEP-FOCUS EARTHQUAKES IN RELATION TO HE COSMIC CONDITIONS OF THE EARTH: Akad. auk SSSR, Izvestiya, Geophysics Ser., in transla- on, 1959, no. 4, p. 415-420, 3 figs., 3 tables, pub. ay 1960, 8 refs.

In previous studies on the temporal occurrence of arthquakes in their relation to cosmic factors, par- cularly to the position of the moon on its oribt, Tam- azyan has shown that there is a definite triggering ffect of the moon on earthquakes occurring at a given oint. Such correlation has been claimed for the arthquakes in the Caucasus, in the Turkmen SSR, d in some other regions. In the present study such relationship is shown to exist in other places, such numerous islands of the Pacific Ocean, in North d South America, and in southern and southeastern ortions of Europe. Two cosmic factors affect the ccurrence of earthquakes in a region: the position the moon on its orbit (near the perigee or the ogee) and the phases of the moon (the full and new oon). Tamrazyan emphasizes the preponderant .S. direction of deep geotectonic fractures; this is plained by the fact that the tides circling the globe om E. to W. favor the displacement of the deep asses of the earth in this direction. The effect of e moon's position decreases as focal depth in- reases, and is obscure at depths greater than 400 n.--S.T. Vesselowsky (courtesy Geophysical bstracts 178-55).

2-2964. Puchkov, S.V., R.I. Khovanova. THE KYREN EARTHQUAKE OF AUGUST 10, 1958: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 6, p. 629-632, 5 figs. incl. map, graph, table, pub. June 1960, 2 refs.

The region around Kyren, Buryat A.S.S.R. is known as an area of seismicity 8-9. After the earthquake (class 9) of April 4, 1950, a seismological expedition was sent to this region by the Institute of Earth Physics to establish provisional seismic stations at 7 points along the Irkutsk river valley. The seismographs of these station, with about 25,000 magnifications, were thrown out of order by the first shock of the earthquake of Aug. 10, 1958. Fortunately, the Kyren station, nearest to the epicenter was provided with an accelograph (system Puchkov) with a magnification of only 6; seismograms were obtained from this instrument. From S-P arrival times, the epicentral distance Δ was determined as 16±5 km. The distance Δ was also determined by the method of hyperbolas; agreement between the results of the 2 methods was very good. The cause of the earthquake was evidently a rupture along the NW. border of the Tunka depression.--S.T. Vesslowsky (courtesy Geophysical Abstracts 178-38).

2-2965. Levitskaya, A. Ya., and M.V. Muratov. THE RELATIONSHIPS OF SEISMICITY AND TECTONIC STRUCTURE IN THE BLACK SEA DEPRESSION AND ADJACENT AREAS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 4, p. 369-375, map, pub. May 1960, 31 refs.

The seismicity of the Black Sea depression and adjacent areas is described and its relationship to the tectonic structure is discussed. Included is a seismotectonic map showing the distribution of epicenters of the main earthquakes relative to their intensity, focal depth, and accuracy of determination. --Auth.

2-2966. Popov, G.I. ON THE LOCATION OF THE EPICENTERS OF TSUNAMIGENIC EARTHQUAKES IN THE FAR EAST: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 858-860, map, pub. July 1960, 8 refs.

Submarine landslides due to earthquakes in the Kamchatka-Kurile area extend over broad areas and involve an enormous volume of water; great tsunami can thus be produced. This feature of earthquakes is to be taken into consideration in evaluating the tsunami danger.--S.T. Vesselowsky (courtesy Geophysical Abstracts 180-49).

2-2967. Solovev, S.L., and N.V. Shebalin. TSUNAMI AND THE INTENSITY OF KURIL-KAMCHATKA EARTHQUAKES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 854-857, 3 diags., table, pub. July 1960, 9 refs.

The U.S.S.R. is now organizing a service in the Far Eastern region to alert the population to the danger of impending tsunami. Special seismic stations will be installed for the rapid determination of the coordinates of earthquake foci. Criteria must be established for recognizing an earthquake that will cause a tsunami. It has been established empirically that tsunami are produced only by an earthquake of magnitude ⩾ 7 1/4. A nomogram covering the Far Eastern region is reproduced; it gives the degree of danger from an incoming tsunami for any epicentral distance.--S.T. Vesselowsky (courtesy Geophysical Abstracts 180-50).

2-2968. Sikharulidze, D.I. **STUDY ON THE DISPERSION OF LOVE WAVES DURING NEAR EARTHQUAKES:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 4, p. 410-414, 6 figs., 3 tables, pub. May 1960, 15 refs.

Surface waves, especially Love waves, produced by earthquakes in the Dzhavakhet highlands (Caucasus) have been studied in the records of 15 earthquakes obtained at the seismic stations at Tbilisi and Yerevan.

Epicentral distances were 125-150 km. at Yerevan and 85-104 km. at Tbilisi; the S-P intervals were 15-19 sec. at Yerevan and 11-13 sec. at Tbilisi. Foci were determined on the basis of some 10-15 other stations in addition to Tbilisi and Yerevan. The thickness of the sedimentary section is calculated to be 4 km. at Tbilisi and 5 km. at Yerevan. The group velocity of the Love waves was found to vary with the frequency from 2.6 to 3.0 km./sec.; periods ranged from 4 to 10 sec.--S.T. Vesselowsky (courtesy Geophysical Abstracts 179-94).

2-2969. Savarensky, E.F., and I.V. Ayvazov. **ON THE DETERMINATION OF THE AZIMUTHS AND EMERGENCE ANGLES OF A SEISMIC RADIATION:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 3, p. 253-259, 4 figs., 3 tables, pub. May 1960, 4 refs.

The paper adduces the determination and analysis of angle parameters of the seismic rays of longitudinal waves, based on data obtained from 2 earthquakes in 1957.--Auth.

2-2970. Savarensky, E. F., O.N. Soloveva, and B.N. Shechkov. **ON LOVE WAVE OBSERVATIONS AT MOSCOW SEISMIC STATION AND ON THE STRUCTURE OF THE EARTH'S CRUST:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 5, p. 469-473, 4 diags., 4 tables, pub. June 1960, 12 refs.

The paper discusses determination of the thickness of the earth's crust by means of analysis of Love waves, assuming a one- and a two-layered model of the crust. Use is made of propagation data of Love waves that have been observed over the wavepath from the vicinity of Japan to the seismic station of Moscow.--Auth.

2-2971. Savarensky, E.F., and D.I. Sikharulidze. **DETERMINATION OF THE THICKNESS OF THE EARTH'S CRUST FROM LOVE WAVE DISPERSION OBSERVATIONS:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 6, p. 620-622, 3 figs., pub. June 1960, 3 refs.

An analysis of the dispersion of Love waves propagating from the epicenters of several earthquakes that occurred in E. Africa, central Asia, China, Japan, and the Pacific area. Seismograms of the Tbilisi seismic station were used, together with records of numerous other Russian and W. European stations. Crustal thickness is greatest (55±5 km.) in the direction toward the Himalayas, Tibet, Pamir, and China. In a second trace, representing earthquakes at epicentral distances between 39° and 52°, the thickness is 45±5 km., and in the third, toward E. Africa, it is 35±5 km. In some directions the structure of the crust has been investigated by means of observations of near earthquakes and artificial explosions. The results are in satisfactory agreement with those obtained from near earthquake and explosion data, where available.--S.T. Vesselowsky (courtesy Geo physical Abstracts 178-264).

2-2972. Shirokova, E.I. **SOME FACTS ON THE CHARACTER OF THE VELOCITY CHANGE IN THE UPPER LAYERS OF THE EARTH'S MANTLE:** Aka Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 804-813, 6 figs. incl. maps, diags., pub. July 1960, 12 refs.

Based upon an analysis of the amplitudes of long tudinal waves from deep focus earthquakes which o curred in the Hindu Kush, the character of the velo ity change in the propagation of longitudinal waves the upper layers of the mantle of the earth (down to a depth of 200 km.) is determined. The direction o the radiation from the earthquake's focus is accoun for. The data obtained show that the low-velocity layer which begins, as is commonly assumed, at a depth of 60-100 km. can reach at least to a depth o 200 km., and that it has fairly discontinuous boundaries.--Auth.

2-2973. Vvedenskaya, A.V., and L.M. Balakina. **DOUBLE REFRACTION IN THE EARTH'S MANTLE** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 814-819, 3 figs., pub. July 1960, 7 refs.

Observations of the field of displacement of long tudinal (P) and transverse (SV, SH) waves propagati in the mantle of the earth, disclose an increase in the amplitudes of P and of SV waves in relation to SH waves during the penetration of seismic rays to the depths of 250-500, 900-1,000, 1,200-1,300, 1,800, and about 2,200 km. These peculiarities of the displacement field may be connected with a polarizatio of the transverse waves during double refraction in the anisotropic layers of the earth's mantle which correspond to the depths enumerated above.--Auth.

2-2974. Rykunov, L.N. **P-WAVES DIFFRACTED AT THE EARTH'S CORE AND RIGIDITY OF THE CORE:** Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 7, p. 678-684, 10 diags., pub. July 1960, 16 refs.

The possibility of evaluating the shear modulus o the earth's core is investigated on the basis of stud ing the character of decrease of amplitudes of P-waves in the shadow zone. In view of the considerable difficulties which arise in a theoretical study o the diffraction of seismic waves at the earth's core the investigation is carried out by the method of mo els.--Auth.

2-2975. Ivakin, B.N. **THE MICROSTRUCTURE AND MACROSTRUCTURE OF ELASTIC WAVES IN ONE-DIMENSIONAL CONTINUOUS NONHOMOGENEOUS MEDIA:** Am. Geophys. Union, Soviet Researc in Geophysics, in English translation, v. 3, 113 p. 28 figs. incl. diags., graphs, New York, Consultan Bureau, [1960], 30 refs.

Originally published as Mikrostruktura i Makrostruktura Uprugikh Voln v Odnomernykh Nepreryvnykh Neodnorodnykh Sredakh, Akademiya Nauk SS Geofizicheskii Institut, Trudy no. 39 (166), Moscow 1958.

The paper, with the aid of the theory of electric 4-pole transmission lines, treats the general meth of the solution of a whole class of non-dimensional wave problems for nonhomogeneous continuous me cluding wave problems relating to media with connuously varying elastic characteristics. The author troduces the concept of the differential propagation onstant, with the aid of which the wave problems are olved, and, on the other hand, the microstructure f the waves in nonhomogeneous media is studied. he solutions to the wave problems are presented in perational form, making it possible to study the ransient behavior of oscillations in nonhomogeneous edia by the techniques of operational calculus.

A detailed investigation of the micro- and macrotructure of sinusoidal waves is carried out for a umber of nonhomogeneous media: 1) with a single nterface, 2) with 2 interfaces, 3) with periodically epeating layers.

As a result of the consideration of the microstrucure of the resultant waves, the laws governing the ariation of the differential velocity (phase velocity f propagation of a wave, measured over an infinitesmally small baseline), are determined, as a function f the wave impedance ratio at interfaces, the cordinate x of the one-dimensional nonhomogeneous edium, and the frequency ω. The amplitude variaions in the resultant wave are subjected to study at he same time. The investigation extends to a conideration of velocity waves $\overline{V}$, pressure waves $\overline{T}$, nd intensity waves $\overline{Q}$ in nonhomogeneous media.

As a result of the study of the macrostructure of he waves in nonhomogeneous media, the frequency ependencies of the phase velocities, measured over finite baseline (dispersion curves), are obtained, n the case of a single interface, 2 interfaces, and a eriodically repeating structure of layers.

The paper subjects to detailed investigation periodically layered media, having 2 layers accommodated within a period of the structure. The equations obtained for the cut-off frequencies make it possible o determine the cut-off frequencies that define the imits of the pass (transparency) band and attenuation and in the medium in question.

For frequencies $\omega \rightarrow 0$, the (integral) velocities or the $\overline{V}$, $\overline{T}$, and $\overline{Q}$ modes in discrete layers are determined, as well as in a whole section or over some arbitrary baseline of a periodically layered medium.

Graphs are constructed for the (integral) velocity of propagation for a section of a periodically layered medium, as a frequency function (dispersion curves), and are compared with the value of the velocity computed on the basis of the formula for mean velocities borrowed from geometric seismics and, in connection with that and with previous findings, the limits of applicability of geometric seismics in the treatment of one-dimensional nonhomogeneous media are considered.

At the end of the paper, the solution of the wave problem in periodically layered media having an arbitrary number of layers within a period of the structure is considered briefly.

Finally, the solutions obtained for continuous media may be applied to the design of discrete (lattice) models. This requires replacing the wave impedance $\overline{W}$ and the propagation constants $\bar{q}_0$ of continuous layers of the media by the corresponding known values of the wave impedances and of the propagation constants of discrete "homogeneous layers" of the model.--Auth. summ.

2-2976. Podyapolsky, G.S. I. THE PROPAGATION OF ELASTIC WAVES IN A LAYERED MEDIUM: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 788-793, 2 figs., pub. July 1960, 6 refs.

The paper analyzes the application to a multilayered medium of functional-invariant solutions of the dynamic problems of the theory of elasticity as suggested by Smirnov and Sobolev, as well as the asymptotic evaluations of wave fields in the neighborhood of fronts of reflected and head waves, obtained by Zvolinsky on the basis of this method. The analysis is limited only to those phenomena which are related to the characteristics of the wave field of the unit elementary wave. The phenomena which are basically related to the interference of the elementary waves are not analyzed in this paper.--Auth.

2-2977. Podyapolsky, G.S. THE PROPAGATION OF ELASTIC WAVES IN LAYERED MEDIA. II: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 9, p. 913-919, 2 tables, pub. July 1960, 7 refs.

The paper continues the analysis of an arbitrary elementary wave begun in pt. 1 (see above). An exact expression is adduced for an axisymmetric case, and a general method is given for the determination of approximate expressions for the individual rapidly changing parts of the displacement field - the seismic waves.--Auth.

2-2978. Khaykovich, I.M., and L.A. Khalfin. EFFECTIVE DYNAMIC PARAMETERS OF ELASTIC MEDIA FOR THE PROPAGATION OF PLANE TRANSVERSE POLARIZED WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 6, p. 579-584, diag., pub. June 1960, 2 refs.

A solution is found to the problem of the passage of a plane transverse polarized wave through a 2-component medium with 1 component dispersed regularly through the other. Expressions are obtained for the effective velocity of the transverse wave and for the effective density. It is shown that for certain conditions of the medium, exponential absorption and dispersion regimes are established.--Auth.

2-2979. Parkhomenko, I.S. ON THE INTENSITY OF A WAVE WHICH HAS PASSED THROUGH A SERIES OF LAYERS WITH HIGHER VELOCITY. I: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 5, p. 474-479, 2 illus., 3 diags., 3 graphs, table, pub. June 1960, 20 refs.

The paper adduces the results of the investigation of the intensity of a head wave passing through a series of layers having a higher velocity which are located at sufficiently great distances from one another, with which the multiple-reflected waves between the layers are not superimposed upon the passing wave. The investigation was carried out with solid-liquid models by means of a supersonic impulse seismoscope. The investigation demonstrated that the amplitude of a wave which has passed through a series of layers may be both greater and lesser than the amplitude of a wave which has passed through a single layer, the thickness of which equals the total thickness of the series of layers.--Auth.

2-2980. Parkhomenko, I.S. ON THE INTENSITY OF A WAVE WHICH HAS PASSED THROUGH A SERIES OF LAYERS HAVING AN INCREASING VELOCITY. II: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 6, p. 585-590, 7 graphs, pub. June 1960, 3 refs.

The paper adduces approximate calculations of the intensity of a plane standing wave which has passed through a series of layers having an increasing velocity and a finite thickness, and which are located sufficiently apart from one another so that no multiple reflected waves are superimposed upon the passing wave between the layers. A comparison to the findings of the experimental investigations with model-simulation produces good agreement.--Auth.

2-2981. Radzhabov, M.M. THE ACCURACY OF INTERFACE VELOCITY DETERMINATION FROM A SYSTEM OF OVERTAKING TRANSVERSE TRAVEL TIME CURVES OF REFRACTED WAVES. II: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 3, p. 304-310, 7 diags., 3 tables, pub. May 1960, 4 refs.

Continuation of the study by Radzhabov of the determination of boundary velocities, using a system of traveltime curves of refracted waves (see GeoScience Abstracts 2-1182). Radzhabov evaluates the magnitude of the error of this procedure. The boundary velocity is determined graphically from the inclination of the segment of the straight line representing the difference of the observed moments of time. This segment is an element of the traveltime curve. In this procedure the fundamental condition of the method of least squares is approximately fulfilled. The accuracy of determination of boundary velocity in this case is dependent mainly upon the length of the base line of measurements and upon the angle ϕ of the inclination of the given segment of the traveltime curve. Radzhabov also determines the necessary length of the base line that determines the boundary velocity with an error not exceeding 10%; the greater the length of the base line, the greater the accuracy of the determination. A theoretical comparison of 2 methods is presented, namely, when a system of reversed traveltime curves is used, shot from opposite ends of the observation line, and when a system of traveltime curves is used, shot from consecutive points of a line perpendicular to the line of observation. Radzhabov finds that the second procedure gives a slightly higher accuracy. On the basis of the experience gained with the procedure, Radzhabov recommends its use in all cases where the refracting boundary is not too sharply curved.--S.T. Vesselowsky (courtesy Geophysical Abstracts 180-369).

2-2982. Epinateva, A.M., and N.G. Mikhailova. THE DETERMINATION OF TYPES OF REFLECTED MULTIPLE WAVES BY THEIR KINEMATIC AND DYNAMIC CHARACTERISTICS: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 7, p. 685-695, 12 figs., pub. July 1960, 16 refs.

Presents the experimental data on the kinematic characteristics of multiple reflected waves recorded with a medium-frequency ($\underline{f}$ = 37 c.p.s.) and high-frequency ($\underline{f}$ = 105 c.p.s.) instruments. These instruments were used to determine types of multiple waves. By using the wave amplitude, it is possible to define more accurately the wave propagation with multiple reflections.--Auth.

2-2983. Epinateva, A.M. INTERFERING MULTIPLE-REFLECTED WAVES: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 779-787, 7 figs. incl. diags., graphs, 4 tables, pub. July 1960, 5 refs.

Discusses the problems of a number of longitudinal multiple waves which develop in some types of horizontally-layered media and of the amplitudes the interfering multiple-reflected waves. The co parison of amplitudes of the multiple-reflected an primary waves for certain types of media shows t starting with a certain time the interfering multip waves can be more intensive than once reflected waves and will lead to the predominance of the mu ple waves on the record. This discussion is conduc for normal incidence waves.--Auth.

2-2984. Gynkina, N.M., and S.I. Massarsky. MICROSEISMS FROM LAKE ISSYK-KUL: Akad. N SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 6, p. 623-628, 7 figs. incl. maps, profiles, pub. June 1960, 2 refs.

In addition to the usual microseismic vibration with a period of 5-7.5 sec., microseisms with a period of 1.8-3.0 sec. are observed from time to time on the seismograms of the geophysical statio at Alma-Ata in the Kazakh S.S.R. These vibratio persist for 1 to 2 days and are more often observe during the cold months (Oct.-March). It impossib to attribute these vibrations to some industrial eff After studying the meteorological conditions accor panying the appearance of the short-period microseisms, the authors conclude that the conditions favorable to their generation are strong W. winds the western shore of Issyk-Kul and E. winds on th eastern shore. Such winds produce standing wave in the water of Issyk-Kul. In contrast to long-per microseisms, the short-period microseisms exte over a rather limited area. Thus the seismogram of the Semipalatinsk station, located about 800 km from lake Issyk-Kul, do not show these microseis --S.T. Vesselowsky (courtesy Geophysical Abstra 178-317).

2-2985. Zverev, S.M. THE USE OF SOUND RE ORDS FOR DISTANCE DETERMINATION DURING OPERATIONS OF DEEP SEISMIC SOUNDING AT SEA: Akad. Nauk SSSR, Izvestiya, Geophysics Se in translation, 1959, no. 4, p. 385-392, 10 figs., table, pub. May 1960, 11 refs.

Based on the analysis of the kinematic picture the arrival of sound and on the comparison of this picture with the observed sound recordings, meth are suggested for determining distance from the s point to the recording station with an error not ov 1%.--Auth.

2-2986. Bayuk, E.I. METHODS FOR DETERMINING THE ELASTIC PARAMETERS OF ROCK SPECIMENS: Akad. Nauk SSSR, Izvestiya, Geoph cis Ser., in translation, 1959, no. 6, p. 633-635, chart, table, pub. June 1960, 7 refs.

It is often important in geologic studies to know the velocity of propagation of seismic waves in ro at high pressure and high temperature. Such dete minations can be conveniently made in the laborat only on short specimens. The elastic wave veloci ties in a relatively short rod and in an infinite vol ume are connected by known relationships which a affected by the dimensions of the rod and the seis wave length used in the experiments. The same r tionships of the theory of elasticity make it possib to determine Poisson's coefficient and other elasti parameters. Bayuk used in his experiments an ul sonic impulse seismoscope, which made it possib to vary the wave lengths propagating along the sp men. Sandstone, syenite, and Al alloys were investigated. The results are in good agreement with the data obtained by other scientists in laboratory experiments and in seismological studies.--S.T. Vesselowsky (courtesy Geophysical Abstracts 178-104).

2-2987. Nikitin, V.N. RECORDING OF CONVERTED REFRACTED $P_1S_2P_1$ WAVES FOR THE PURPOSE OF COMPUTING THE ELASTIC CONSTANTS OF DIABASE COVERED BY ALLUVIUM: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 8, p. 794-803, 8 figs. incl. diags., graphs, seismograms, *pub.* July 1960, 25 refs.

Described here is an example of recording converted refracted $P_1S_2P_1$ waves. The criteria for identifying converted waves of this type are discussed. The results of determining Young's modulus for diabase from the velocities of longitudinal and transverse waves on a large number of profiles are presented, as well as an evaluation of the relative errors resulting from the computation of Young's modulus by approximation (from the velocity of the longitudinal waves) resp. [sic] exact methods (from the velocities of the longitudinal and transverse waves).--Auth.

2-2988. Moore, David G. ACOUSTIC-REFLECTION STUDIES OF THE CONTINENTAL SHELF AND SLOPE OFF SOUTHERN CALIFORNIA: Geol. Soc. America, Bull., v. 71, no. 8, p. 1121-1136, map, 5 profiles (4 fold.), 2 diags., table, Aug. 1960, 31 refs.

Acoustic-reflection profiles showing the thickness of marine sediments and details of the structure at shallow depth within underlying bedrock make available new quantitative data for sedimentological and structural study of submerged continental margins.

Acoustic profiles across narrow continental shelves and upper basin slopes off southern California show barren wave-cut rocky shelves. In other localities they show wave-cut rock surfaces covered with up to 60 ft. of "Recent sediment." More complex areas have what is believed to be Pleistocene alluvium covering a strong reflecting surface, probably older bedrock, with Recent sediments superimposed. A majority of the southern California basin slopes are believed to be dip slopes of adjacent landward structures shown on the recorded profiles.

Recent sediments range widely in thickness and are generally lenticular with greatest accumulation on the central part or inner part of the shelf. These deposits mark our modern drowned shelves as areas of real or potential deposition; the body of California shelves, however, is made up of ancient rocks and structures modified by wave planation in lowered Pleistocene seas. The present depth and profile of California shelves are vestiges of the Pleistocene which have been slightly or locally modified.

Shear-strength tests of sediment from special continental-slope cores taken off southern California indicate that these steep slopes are at least locally stable and that considerably greater thicknesses of sediment could accumulate on them. Acoustic penetration of these slope deposits shows they are relatively thin compared to nearby shelf deposits. These relatively thin but structurally stable slope deposits indicate that much of the detritus introduced to the continental shelf in this area may be carried diagonally across the shelf and trapped by canyons which act as arteries of distribution to the deep sea.

Sediment cover and the structure at shallow depths of the continental shelf and upper slope together with shear-strength tests of slope deposits off California indicate that most theories of the origin of the continental terrace may be too generalized.--Auth.

2-2989. Kogan, R.M. A METHOD FOR CALCULATING THE CONCENTRATION OF THE AIR DOSE OF GAMMA-RADIATION IN HOMOGENEOUS GEOLOGIC MEDIA: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 7, p. 701-704, table, *pub.* July 1960, 11 refs.

A method is described which is based on simple energy considerations. The method can be considered accurate for airlike media. At primary gamma-quanta energy of 0.3 to 3.0 Mev the method can be used for calculating the concentration of the air dose in rock specimens and is recommended, due to its simplicity and adequate accuracy (not less than 5 to 10%), for practical computations.--Auth.

2-2990. Adams, John A.S., and K.A. Richardson. RADIOACTIVITY OF ALUMINUM METAL: Econ. Geology, v. 55, no. 5, p. 1060-1063, 4 tables, Aug. 1960, 5 refs.

Although Al is produced from bauxite containing 74 p.p.m. Th and 3.6 p.p.m. U, less than 5% of these amounts is extracted with the alumina in processing. The radioactivity of Al metal is comparable with that of other common metals.--J.A. Chamberlain.

2-2991. Vorobev, V.A. THE FEASIBILITY OF USING SHIELDED DETECTORS IN AIRBORNE RADIOMETRIC PROSPECTING: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 7, p. 705-709, 2 figs., *pub.* July 1960, 14 refs.

The author analyzes the problem of raising the effectiveness of recording local aero-gamma anomalies with deeply shielded detectors. The separation factors for ray approximation are computed and the relations for selecting the optimum shield aperture (θ_{opt}) and the radiometer time constant (τ_{opt}) are obtained. It is shown here, that the use of round, conical shields is feasible if $I_{rb} < 0.3\, I_o\, \phi(\mu h)$, where $I_o\, \phi\, (\mu h)$ is the intensity of the earth's gamma field at flight altitudes, and I_{rb} is the residual background. The influence of the shape of the shield on the quality of the gamma survey is discussed.--Auth.

2-2992. Senko-Bulatny, I.N. NEUTRONOMETRY OF HOLES IN DEPOSITS OF MANGANESE AND BOXITES [SIC]: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 3, p. 325-328, 4 diags., table, *pub.* May 1960, 7 refs.

The results of logging of Mn and bauxite deposits by various methods are presented. These investigations were made using gamma logging, neutron-gamma logging, and the method of induced activity. Procedures are described. Surveys were made by all 3 methods in each of 2 areas in the northern Kazakh SSR. The curves obtained are reproduced. Clearer indications were obtained with neutron-gamma logging.--S.T. Vesselowsky (courtesy Geophysical Abstracts 180-340).

2-2993. Verhoogen, John. TEMPERATURES WITHIN THE EARTH: Am. Scientist, v. 48, no. 2, p. 134-159, chart, diag., 5 graphs, table, June 1960, 27 refs.

The article, a Sigma Xi-RESA lecture, discusses the earth's internal structure and properties of rocks affecting temperatures within the earth. Heat flow from the earth and dissipative geologic processes - volcanism, diastrophism, and metamorphism - require large amounts of heat which is probably of radiogenic origin. Phonon conductivity, radiation, and convection are evaluated in light of possible distribution of radioactive rocks and the theories of earth structure. From a review of physical properties of the earth and influences of heat and pressures upon solids, a temperature near 2,600°K is given for the mantle-core boundary. At a depth of 200 km., temperatures should be about 1,500°C. and at 100 km. depth they are probably 1,100°-1,200°C.

Considering the energy balance of a core in convection motion leads to a suggestion that the latent heat of recrystallization of the inner core must be growing. In conclusion it is considered that the core is cooling and had a high initial temperature.--T. H. W. Loomis.

2-2994. Kabuzenko, S.N. THE THEORY OF THERMAL DEFORMATIONS OF THE EARTH'S SURFACE: Akad. Nauk SSSR, Izvestiya, Geophysics Ser., in translation, 1959, no. 3, p. 300-303, table, pub. May 1960, 4 refs.

The daily variations of the inclination and of the linear deformation of the surface of the earth have a common cause, namely the irregularity of the surface heating. The observable daily thermal deformation of the earth is a narrowly local process, touching only the very upper layers. The lag in the daily thermal inclinations of the earth's surface can be explained by the presence of loose, heat-insulating material on the surface of the earth.--Auth. concl.

2-2995. Hodgson, John H., comp. NATIONAL REPORT FOR CANADA: SEISMOLOGY AND PHYSICS OF THE EARTH'S INTERIOR, 1957-1960: Canada, Dominion Observatory, Contr., v. 3, no. 25, 28 p., 1960, 124 refs.

This report was prepared on behalf of the National Committee for Canada and of its subcommittees on gravity, radioactivity and heat flow, and seismology. It is intended to cover all noncommercial geophysics in those fields which are of interest to the Association of Seismology and Physics of the Earth's Interior. Work in the following fields is reported: seismology (earthquake, theoretical and laboratory, field, engineering); radioactivity, by the Geological Survey of Canada, universities of Toronto, Western Ontario, Alberta, British Columbia, and McMaster University; heat flow; tectonophysics; and gravity (regional mapping and structural studies, other mapping and investigations, earth tide measurements, isostatic studies).--A. C. Sangree.

7. GEOCHEMISTRY

See also: Stratigraphy 2-2861, 2-2862, 2-2864; Paleontology 2-2886; Sedimentary Petrology 2-3055, 2-3058; Mineral Deposits 2-3082, 2-3083.

2-2996. Haffty, Joseph. RESIDUE METHOD FOR COMMON MINOR ELEMENTS: U.S. Geol. Survey, Water-Supply Paper 1540-A, 9 p., diag., 3 tables, 1960, 9 refs.

A spectrographic method is described for the quantitative analysis of many minor elements in natural water. The excitation of the water residue using a direct-current arc provides a method for the detection of elements present in very low concentrations. The concentration of the elements is determined in percent of the dry residue. The results are readily expressed in parts per million by multiplying the determined percent concentration of an element by the dissolved solids content of the water sample. The method is flexible and can be applied to the analysis of water of variable composition and dissolved-solids content.--Auth.

2-2997. Olsen, Edward J. AN ATTEMPT TO SYNTHESIZE GRAPHITE BY THE DISSOCIATION OF CARBON DIOXIDE - THE EXPERIMENT OF K. FRAUENFELDER: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 147, Apr. 1960, 5 refs.

The experiments of Frauenfelder on the catalytic dissociation of CO_2 to graphite at 1,100°C. were repeated. No variation in the experimental conditions were found to produce graphite at temperatures to 1,150°C. It is therefore concluded that Frauenfelder's results have no validity.--F. Manheim.

2-2998. Ellis, A.J. MORDENITE SYNTHESIS IN A NATURAL HYDROTHERMAL SOLUTION: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 145-146, Apr. 1960, 5 refs.

The zeolite, mordenite, was synthesized from a powdered obsidian which was suspended at 1,045 ft. depth in the bore of an active hydrothermal system. The temperature at this point was 230° and an in situ pH of 5.7 was calculated from a chemical analysis of the water. The study showed that the frequently used term "alkaline thermal area" may be misleading, and that zeolites do not crystallize only from alkaline solutions.--F. Manheim.

2-2999. Wyllie, P.J., and O. Frank Tuttle. EXPERIMENTAL INVESTIGATION OF SILICATE SYSTEMS CONTAINING TWO VOLATILE COMPONENTS. PART I. GEOMETRICAL CONSIDERATIONS: Am. Jour. Sci., v. 258, no. 7, p. 498-517, 10 figs. incl. diags., graphs, Summer 1960, 11 refs.

This is the first in a series of papers describing the effects of volatile materials, in addition to water, on the melting temperatures of albite and granite. In order to understand the results obtained, familiarity with the geometry of ternary isobaric (TX) prisms is required. A detailed description of the PTX model for the system albite-water is followed by description of the phase spaces, surfaces and lines in the TX prisms produced by adding a second volatile, C, to the components albite-water. The shape of the liquidus field boundary depends upon the solubilities of water, C, and mixtures of water and C in the silicate liquid. At constant pressure, the second volatile C may raise or lower the melting temperature in a binary silicate-water system. Possible arrangements of the liquidus and vaporus field boundaries between the bounding binary systems albite-water and albite-C are: 1) they pass continuously in temperature and composition from one binary system to the other, 2) they have a temperature maximum, and 3) they have a temperature minimum. These types will serve as models for the experimental data in later papers in the series. Published data in the systems albite-H_2O-CO_2, "granite"-H_2O-CO_2 and CaO-CO_2-H_2O are compared with the models described.--Auth.

2-3000. Mueller, Robert F. COMPOSITIONAL CHARACTERISTICS AND EQUILIBRIUM RELATIONS IN MINERAL ASSEMBLAGES OF A METAMORPHOSED IRON FORMATION: Am. Jour. Sci., v. 258, no. 7, p. 449-497, 11 figs. incl. map, diag., graphs, 5 tables, Summer 1960, 17 refs

The Fe formation is located in E.-central Quebec and probably is a regionally metamorphosed equivalent of the Fe-bearing sediments of the Labrador trough. Mineral assemblages are composed of select combinations of the following: quartz, talc, actinolite, Ca-pyroxene, cummingtonite, magnetite, hematite, calcite, and dolomite. Seventy-six spectrographic analyses of minerals give the following average concentration ranges for minor constituents: Al_2O_3, MnO, and $Na_2O < 1\%$; $K_2O < 0.1\%$; TiO_2, V_2O_3, Cr_2O_3, NiO, CuO, and $BaO < 0.01\%$. ZrO_2 and SrO were not detected. Therefore the rocks are essentially members of the system CaO-MgO-FeO-O-SiO_2-H_2O-CO_2.

Close approach to chemical equilibrium during metamorphism is indicated by 1) orderly distribution of Mg, Fe, and Mn among coexisting actinolite, Ca-pyroxene, and cummingtonite; 2) restrictions on the numbers and types of minerals in association with each other; and 3) correlation of the compositions of silicates with the presence and absence of hematite, i.e., Mg/(Mg+Fe) is increased and its range restricted when hematite is present.

Distributions of elements among coexisting minerals may be interpreted in terms of thermodynamic theory and in some cases may be represented by functions derived on the assumption of ideal soild solutions. Observed mineral assemblages and their compositional relations are in general consistent with phase rule considerations and may be elucidated by functions based on the coupling of chemical reactions between minerals.--Auth.

2-3001. Fyfe, W.S. THE POSSIBILITY OF d-ELECTRON COUPLING IN OLIVINE AT HIGH PRESSURES: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 141-143, diag., Apr. 1960, 12 refs.

The conditions under which d-electron coupling in olivine may take place are discussed. The most important aspects of such a coupling process will be the formation of stronger covalent bonds and a reduction in volume. Conversely, coupling is favored by an increase in pressure.

While data is at present insufficient for precise calculations, it is suggested that d-coupling in olivine, with its attendant volume contraction, is probable in the earth's mantle.--F. Manheim.

2-3002. Maringer, R.E. ABLATION DEPOSITS ON IRON METEORITES: Geochim. et Cosmochim. Acta, v. 19, no. 1, p. 5-6, 2 illus., March 1960, 2 refs.

Ablation of Fe meteorites is considered to occur mainly by the sweeping away of a molten surface layer. Evidences for this conclusion include surface structural alterations and hardness gradients associated with the effects of aerodynamic heating. An alternate ablation hypothesis would be direct vaporization, but the lamellar appearance, abundance, and locations of the ablation deposits do not appear to be consistent with such a mechanism.--F. Manheim.

2-3003. Gast, Paul W. ALKALI METALS IN STONE METEORITES: Geochim. et Cosmochim. Acta, v. 19, no. 1, p. 1-4, table, March 1960, 9 refs.

K, Rb, and Cs determinations were made on 10 chondrites and 5 achondrites by means of stable isotope dilution techniques. The average K/Rb and K/Cs ratios in chondrites and achondrites were 280 and 7,500, and 1,360 and 28,900, respectively. No correlation could be found between Rb and Cs or K and Rb for the chondrites, while there is good correlation in the achondrites.

It is suggested that the marked differences in the K/Rb and K/Cs ratios between chondrites and achondrites may be a result of fractionation of alkali metals in a parent mass due to differences in vapor pressure.--F. Manheim.

2-3004. Morris, D.F.C., and R.A. Killick. SILVER AND THALLIUM CONTENTS OF ROCKS: Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 139-140, 2 tables, Apr. 1960, 4 refs.

Neutron activation results are presented for the Ag and Tl contents of the standard granite and diabase, G-1 and W-1, and a suite of Scottish igneous rocks. The average values for G-1 and W-1 are given below in p.p.m.

	Ag	Tl
G-1	.042	1.3
W-1	.057	.17

The present data appear to support previous estimates for the abundance of Ag and Tl in igneous rocks.--F. Manheim.

2-3005. Siroonian, H.A., and others. LITHIUM GEOCHEMISTRY AND THE SOURCE OF THE SPODUMENE PEGMATITES OF THE PREISSAC-LAMOTTE-LACORNE REGION OF WESTERN QUEBEC: Can. Mineralogist, v. 6, pt. 3, p. 320-338, map, diag., graph, 9 tables, 1959, 35 refs.

Sixty-seven separated minerals and 45 rocks from the Preissac-Lamotte-Lacorne batholiths in western Quebec have been analyzed for Li by a spectrochemical method. The batholithic rocks include amphibolite, hornblende monzonite, biotite granodiorite, biotite-muscovite granite, aplite, and pegmatite. The granites are unusually rich in Li which is mainly contained in biotite and muscovite. The region thus constitutes a Li-rich geochemical province, which is also demonstrated by the presence of spodumene pegmatites of economic value.

The source of the spodumene pegmatites has been attributed to fractional crystallization of the batholith magmas on the basis of previous field investigations. The present data substantiate this theory and attempt to explain why the Li-pegmatites are mainly associated with the Lacorne mass.--Auth.

2-3006. Hem, John D. RESTRAINTS ON DISSOLVED FERROUS IRON IMPOSED BY BICARBONATE, REDOX POTENTIAL, AND pH: U.S. Geol. Survey, Water-Supply Paper 1459-B, p. 33-55, 3 diags., 2 tables, 1960, 11 refs.

Chemical equilibrium involving carbon dioxide, bicarbonate, carbonate, and pH influences the amount of ferrous Fe in much natural water. Values of pH computed from assumed equilibrium involving calcite or siderite approximate measured values of pH in 13 of 20 samples of ground water from different geologic terrains; thus, some degree of equilibrium probably existed. Two samples were supersaturated and 5 were undersaturated with respect to both calcite and siderite. Failure to reach equilibrium may result from absence of the minerals in the aquifer, unrepresentative analytical data, lack of reaction time, or chemical complexing.

At equilibrium, pH and Fe content provide a basis for estimating the Eh (redox potential) of ground water. If much bicarbonate is present, however, the amount of Fe dissolved may not change with change in Eh. For 3 samples from artesian wells, the Eh values measured in the field and believed to be valid ranged from + 0.10 to + 0.13 v. (volt); they were no more than 0.03 v. higher than the Eh values computed from the pH and bicarbonate and Fe content. The available data are not complete enough to evaluate the differences. The measured Eh (0.28 v.) of water from a pumped water-table well was 0.18 v. higher than the computed value. This difference was probably due to the effect of O from the atmosphere on the measurement.--Auth.

2-3007. Hem, John D. SOME CHEMICAL RELATIONSHIPS AMONG SULFUR SPECIES AND DISSOLVED FERROUS IRON: U.S. Geol. Survey, Water-Supply Paper 1459-C, p. 57-73, 3 diags, 1960, 8 refs.

S species most likely to occur in natural water are HS^{-1}, H_2S, HSO_4^{-1}, and SO_4^{-2}. Free S (S^o) may be a stable form. The stability fields for these 5 species are shown on an Eh-pH diagram. A second Eh-pH diagram shows the range of conditions under which Fe activity could amount to 10^{-7} molal or more in the presence of solid-phase ferrous sulfide and a total dissolved S content 10^{-5} molal, in the absence of bicarbonate. Reactions involving oxidation or reduction of S are slow but may be speeded by biochemical influences.

If equilibrium is established, natural waters containing a few hundred p.p.m. (parts per million) of SO_4^{-2} and HCO_3^{-1} could contain over 10 p.p.m. of Fe only if pH is less than about 6.1 over a rather wide Eh range. Some ground-water samples are not at equilibrium, however. Wells may obtain water from several poorly interconnected zones in which Eh, Fe, and S content differ.

Oxidation of pyrite evidently can be an important source of Fe in ground water. The changes in Eh with depth below the water table and the fluctuation of the water table may result in stratification of Fe content in ground water and in erratic changes in Fe content of water from wells; they may cause Fe deposits to form in aquifers and wells. Such deposits could reduce the capacity of wells to yield water and might interfere with ground-water movement.--Auth.

2-3008. Hem, John D. COMPLEXES OF FERROUS IRON WITH TANNIC ACID: U.S. Geol. Survey, Water-Supply Paper 1459-D, p. 75-94, 2 diags., 3 tables, 1960, 15 refs.

Solutions of tannic (digallic) acid at concentrations of 5 or 50 p.p.m. reduce dissolved ferric Fe to the ferrous state when the pH is less than 4. In solutions with a pH of 4 or more, a black material containing ferric Fe and tannic acid is precipitated. In a solution containing 500 p.p.m. of tannic acid, a ferrous complex forms at a pH of more than 5. This complex is oxidized at a slow rate, and some ferrous Fe remains in solution after a month of storage in contact with air. Uncomplexed ferrous Fe is oxidized and precipitated from solution in a few hours or less at pH levels of more than 5.

The approximate value of the first dissociation constant for tannic acid is between 1 x 10^{-5} and 1 x 10^{-6}. The stability constant for the ferrous complex is comparable in magnitude to that of the pink bipyridine complex used in the determination of Fe.--Auth.

2-3009. Hem, John D., and Marvin W. Skougstad. COPRECIPITATION EFFECTS IN SOLUTIONS CONTAINING FERROUS, FERRIC, AND CUPRIC IONS: U.S. Geol. Survey, Water-Supply Paper 1459-E, p. 95-110, diag., table, 1960, 9 refs.

Precipitates of ferric hydroxide that form when solutions containing ferrous Fe are raised in pH or Eh may remove other ions from solution by coprecipitation. Solutions containing from 1 to 10 p.p.m. of Fe and about 0.5 p.p.m. of Cu were adjusted to pH values ranging from 3.8 to 8.5 by adding sodium carbonate or sodium bicarbonate. More Cu was lost from solutions whose pH was 5.5 or more than would have been expected had Fe been absent. Stable or metastable colloidal suspensions of ferric hydroxide have a positive zeta potential and do not adsorb Cu; but when the zeta potential decreases or becomes negative as a result of a change (increase) in the pH of the solution, Cu is adsorbed by the ferric hydroxide precipitate.

Fe precipitating from water samples after they have been collected may remove dissolved Cu. Samples from which Fe has precipitated can be acidified at the time of analysis to return all the Cu to solution. Precipitation of Fe can be prevented by lowering the pH of the sample to 4.5 or less at the time of collection if the amount of Cu originally dissolved is to be determined.--Auth.

2-3010. Oborn, Eugene T. A SURVEY OF PERTINENT BIOCHEMICAL LITERATURE: U.S. Geol. Survey, Water-Supply Paper 1459-F, p. 111-190, illus., secs., diags., 3 tables, 1960, 9 refs.

Biochemical factors relating to the occurrence of Fe in natural water were studied by examining more than 800 published articles and abstracts. According to this literature Fe is essential in normal metabolism of most of the fungi, bacteria, aquatic vegetation, and land plants studied as well as in many animals. Many organisms in diverse habitats may precipitate or dissolve Fe. Aquatic plants seem to be important in the Fe cycle in surface-water bodies. They take up Fe from submerged soil or from the water and ultimately release it to water solution or return it to the bottom mud through rapid decay of dead plant material. Anaerobic bacteria in the absence of O reduce precipitated ferric Fe and return it to solution. Apparently, many of these bacteria in the presence of O use the C that is so frequently fixed to Fe in the form of humates, chelates, or other complex compounds. Crustose lichens remove Fe from bare rocks. Other life forms are also involved in the Fe cycle.

Under oxidizing and alkaline conditions, mud layers in lake bottoms act as an adsorbent for the more common insoluble metallic ions. Mud layers reduced by anaerobic bacteria release Fe and the more common metallic ions. The simpler aquatic plants use these metallic ions directly.

The redox potential of water is related to the content of dissolved ferrous and ferric Fe. Fe in organic complexes may be difficult to determine by usual methods of chemical analysis. Special methods and techniques are suggested when the determination is to be performed in the presence of organic matter. --Auth.

2-3011. Sato, Motoaki. **OXIDATION OF SULFIDE ORE BODIES, 1. GEOCHEMICAL ENVIRONMENTS IN TERMS OF Eh AND pH:** Econ. Geology, v. 55, no. 5, p. 928-961, 9 diags., table, Aug. 1960, 64 refs.

The probable ranges of oxidation potential and pH values for the weathering environment and those for the depth environment were studied through 3 approaches, namely field measurements of Eh and pH values of natural waters in mining districts, experimental oxidation of Fe and Mn solutions by air, and theoretical considerations of chemical and mineralogical factors involved in natural systems. The oxidation potential for the weathering environment is found to be largely controlled by the reduction mechanism of O. Hydrogen peroxide forms during the reduction of O in aqueous solution, and is catalytically decomposed back to O plus water by various elements, some of which are common in natural systems. A reversible equilibrium is thus established between hydrogen peroxide and O, resulting in the control of the oxidation potential of the weathering environment by the H_2O_2-O_2 couple. The oxidation potential for the depth environment is probably controlled by oxidation-reduction reactions involving Fe-rich minerals, since Fe is the most common among the elements that occur in more than one state of oxidation in rocks. Limitations may be imposed on the pH values for these environments by the dissociation of ferric hydroxide at the acidic side, and by the hydrolysis equilibrium of calcite at the basic side. An Eh-pH diagram indicating the probable ranges of Eh and pH values for the 2 environments is given.--Auth.

2-3012. Hamer, A.N., and E.J. Robbins. **A SEARCH FOR VARIATIONS IN THE NATURAL ABUNDANCE OF URANIUM-235:** Geochim. et Cosmochim. Acta, v. 19, no. 2, p. 143-145, table, Apr. 1960, 4 refs.

Comparison of the isotopic composition of U from 12 ore deposits has been made by high-precision gas-source mass spectrometry. The maximum possible percentage deviation of the isotope ratio U^{238}/U^{235} from the mean was found to be .046% within 95% confidence limits. These measurements confirm the expectation that natural fractionation effects on U isotopes must be very small.--F. Manheim.

2-3013. Tamers, Murry A. **CARBON-14 DATING WITH THE LIQUID SCINTILLATION COUNTER: TOTAL SYNTHESIS OF THE BENZENE SOLVENT:** Science, v. 132, no. 3428, p. 668-669, Sept. 9, 1960, 9 refs.

Samples are analyzed for natural radiocarbon content by a total synthesis of benzene from their organic constituents. The benzene is employed as the solvent in a liquid scintillation counter. The instrument used permits 15 g. of C to be counted with an efficiency of 40% and a background of 13 counts per min.--Auth.

2-3014. Smith, F. Gordon, and W.M. Little. **FILLING TEMPERATURES OF H_2O-CO_2 FLUID INCLUSIONS AND THEIR SIGNIFICANCE IN GEOTHERMOMETRY:** Can. Mineralogist, v. 6, pt. 3, p. 380-388, 5 diags., table, 1959, 10 refs.

The theoretical significance of the filling temperature of fluid inclusions containing significant amounts of both water and CO_2 is discussed in terms of H_2O-CO_2 mutual solubility. It is shown that the filling temperature can be lower, higher, or equal to the temperature of formation. The method of geothermometry, suggested by Smith in 1953, which is based on the recognition of the cases where the filling temperature is equal to the temperature of formation, is discussed in detail. Six examples are given of its tentative application to minerals from Sn deposits, for which temperatures of formation in the 300-400°C. range were obtained.--Auth.

2-3015. Breger, Irving A., and John C. Chandler. **EXTRACTABILITY OF HUMIC ACID FROM COALIFIED LOGS AS A GUIDE TO TEMPERATURES IN COLORADO PLATEAU SEDIMENTS:** Econ. Geology, v. 55, no. 5, p. 1039-1047, 3 diags., 3 tables, Aug. 1960, 9 refs.

Coalified logs in Triassic and Jurassic sediments of the Colorado Plateau have been exposed to alkaline ground water. Extraction of humic acids under such conditions is temperature dependent. Study of residual humic acids in a suite of coalified logs has indicated that temperatures up to but not over 120°C. prevailed in the sediments. This maximum temperature corresponds with that to be expected from geothermal gradient and estimated from mineralogic evidence.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Paleontology 2-2877; Igneous and Metamorphic Petrology 2-3036, 2-3038; Sedimentary Petrology 2-3059.

2-3016. Dell, Carol I. **METHODS OF STUDY OF SAND AND SILT FROM SOILS:** Can. Mineralogist, v. 6, pt. 3, p. 363-371, 1959, 9 refs.

Methods of cleaning, segregating, and identifying minerals found in the coarse silt and sand fractions of soils are outlined. After a heavy liquid separation, identification was carried out mainly by the use of the petrographic microscope for the coarse silt and fine sand, and the binocular microscope for the medium and coarse sand. The Franz isodynamic separator, a staining technique for the identification of the potash feldspars, and index of refraction oils were also used. The distinguishing characteristics of about 35 minerals are described.--Auth.

2-3017. Anderson, B.W. **GEM TESTING:** 324 p., 93 illus., tables, New York, Emerson Books, 1959, refs.

This volume is descriptive of gem-testing rather than of gems, and it is written mainly for the ordinary jeweller and dealer. It shows the easy scientific tests available for discriminating with certainty between one stone and another and between real stones and their substitutes, and how to apply these tests in practice.--From pref. to 1st ed.

Full descriptions of the new materials and of other developments in synthetic, imitation, and "faked" stones are included in the 5th English edition. In this volume (the 2d American edition and the 6th English edition), more information is given on new synthetic stones such as strontium titanate. A new gem species, "sinhalite," is added to the list of gemstones.

Developments have also taken place on the determinative side. Simple yet powerful methods such as "immersion contact" photography and its offshoots, and the "crossed filter" fluorescence technique, both of which were first introduced by the author, provide tools which can assist the gemologist at little cost in apparatus.

The chapter on the spectroscope has been newly illustrated, and the text has been drastically rearranged for the jeweller or student who may have found this instrument difficult to handle with success. A new chapter has been added on the subject of fluorescence.

Subjects dealt with in this book are as follows: refractive index and its measurement; double refraction and how to detect it; color, color filters, and the dichroscope; specific gravity of gemstones and how to measure it; detection of synthetic and imitation stones; use of the microscope; use of the spectroscope; identification of diamond, ruby, sapphire, emerald, aquamarine and alexandrite, zircon, topaz, pink, mauve, or lilac stones, brown and orange stones, quartz, opal, and the garnets, tourmaline, peridot, and spinel, jade and jadelike minerals, turquoise and lapis lazuli, cat's-eyes, starstones, and others, amber, tortoiseshell, coral, and jet, pearls: real, cultured, and imitation; fluorescence as an aid to identification.

2-3018. Shubnikov, A.V. PRINCIPLES OF OPTICAL CRYSTALLOGRAPHY. Translated from Russian: 186 p., 165 figs., 9 tables, New York, Consultants Bureau, 1960.

The original Russian text was published for the Institute of Crystallography by the Academy of Sciences, U.S.S.R., Press, Moscow, 1958. The text follows the course on optical crystallography given in the Physics Faculty of the Moscow State University. This explains the absence of isolated details and of certain branches of the subject, for example, reflection of light from crystal plates, changes in optical properties of crystals under the action of external effects, etc. The book does not include descriptions of apparatus and experimental methods which are covered by practical classes running parallel with the theoretical course.--From auth. foreword.

The following subjects are dealt with: the subject of optical crystallography; basic ideas from the optics of isotropic transparent media; double refraction; interference of light in crystal plates; rotation of the plane of polarization; elliptical polarization and elliptical double refraction, conical refraction; double absorption of light in crystals.

2-3019. Sabina, Ann P. and R.J. Traill. CATALOGUE OF X-RAY DIFFRACTION PATTERNS AND SPECIMEN MOUNTS ON FILE AT THE GEOLOGICAL SURVEY OF CANADA: Canada, Geol. Survey, Paper 60-4, 116 p., 1960.

Contains details of some 650 X-ray diffraction patterns of minerals with tabulations of measured spacings and estimated intensities of those patterns for which no published X-ray data were available for cross-checking. Patterns are listed by mineral name with full locality information and appropriate bibliographic information.--P. Harker.

2-3020. Burley, B.J., and E.B. Freeman. THE EFFECT OF TEMPERATURE ON THE LATTICE PARAMETERS OF QUENCHED SYNTHETIC ANALCIME: Can. Mineralogist, v. 6, no. 3, p. 372-379, 2 diags., table, 1959, 13 refs.

Mixtures of analcime composition have been crystallized to analcime in the presence of water vapor and at a pressure of 15,000 p.s.i., and at temperatures of 200°C. to 540°C. Most of the runs were of 2 to 8 days' duration. No significant variations in the lattice parameter $2\theta_{400}-2\theta_{211}$ of analcime were observed.--Auth.

2-3021. Johnson, Noye M. THERMOLUMINESCENCE IN BIOGENIC CALCIUM CARBONATE: Jour Sed. Petrology, v. 30, no. 2, p. 305-313, 7 diags., 2 tables, June 1960, 25 refs.

Radio-thermoluminescent potential of calcareous shell material is a function of $CaCO_3$ polymorphism. Calcite fossils have a high capacity for thermoluminescent energy storage. Aragonitic shells are inert with respect to radio-thermoluminescence. Aragonite, however, emits luminescence when it reverts to calcite at approximately 425°C. This light is believed to be a triboelectric discharge associated with the sudden reconstructive phase change.

The shells belonging to a given taxonomic category tend to have similar and sometimes diagnostic thermoluminescent properties. Thermoluminescent correlation and age-dating of limestones must consider the consequences of biomineralogy and its accompanying thermoluminescence.--Auth.

2-3022. Dickey, Dayton D. THERMOLUMINESCENCE OF SOME DOLOMITE, TUFF, AND GRANITIC ROCK SAMPLES FROM THE NORTH-CENTRAL PART OF THE NEVADA TEST SITE, NYE COUNTY, NEVADA - A PROGRESS REPORT: U.S. Geol. Survey, Trace Elements Inv. Rept. 765, 30 p., 7 figs. incl. maps, diags., 5 tables, July 1960, 3 refs.

All of the tuff, dolomite, and granitic rock samples tested were thermoluminescent; of the 3 rocks, the dolomite was the most thermoluminescent and the tuff was the least. Because of the low values and the lack of distinctively shaped thermoluminescence curves for bulk samples of tuff, further work on the thermoluminescence characteristics of the tuf components would be desirable.

The curves for the dolomite samples from 3 different stratigraphic units showed differences large enough so that thermoluminescence may possibly be used as an aid in correlation of stratigraphic units.

Much work will be required to evaluate fully the usefulness and exact method of employing thermoluminescence in measuring effects of underground nuclear explosions. Results of this investigation indicate that some rocks of the Nevada Test Site are sufficiently thermoluminescent to warrant further study of these properties. Continuing work might lead to a supplementary means of measuring extent and quantity of postshot radiation, provide additional data for determining the maximum temperature attained during an explosion for those rocks heated to between 200° and 400°C., assist in identifying different rocks from the broken rock chimney above an explosion and thereby provide clues to identify the original position of these rocks.

If a nuclear explosion were to take place in dolomite or granite, thermoluminescence studies could be made of samples collected both before and after the explosion at various distances from the explosion. Further, it would be desirable at the time of the explosion to have temperature and pressure measuring devices at the positions sampled and compare values thus obtained with the glow curves.

If additional thermoluminescence studies of tuff components reveal a method for obtaining satisfactory glow curves, the above procedure could be used for nuclear explosions in tuff.

Work should be done on the effect of pressure on thermoluminescence, on the effect of long-time exposure to temperatures less than 400° and more than 200°C., on the effect of different kinds and intensities of radiation on rocks, and on extension of the useful temperature range of the method above 400°C.

It should be emphasized that although considerable work has been done in the field of thermoluminescence, much more is necessary properly to evaluate these potential applications.--Auth. concl.

2-3023. Nickel, Ernest H. **THE OCCURRENCE OF NATIVE NICKEL-IRON IN THE SERPENTINE ROCK OF THE EASTERN TOWNSHIPS OF QUEBEC PROVINCE:** Can. Mineralogist, v. 6, pt. 3, p. 307-319, 5 illus., map, 2 diags., 4 tables, 1959, 10 refs.

Native Ni-Fe has been found over a wide area in the serpentinized asbestos-bearing rock of the eastern townships of Quebec. The chemical composition (average of 2 analyses) is: Ni 71.0%, Fe 25.3%, Co 3.5%, and Cu 0.2%. The Ni-Fe forms a single-phase alloy with a face-centered cubic structure and a cell constant which varies from 3.551 to 3.555 Å. It occurs chiefly as tiny spheroidal grains, most of which are less than 10 microns in diameter, but also as large crenulated grains up to 100 microns in diameter, and as acicular crystals up to 100 microns in length. The Ni-Fe appears to have been formed as the result of the breakdown, during serpentinization of primary olivine and enstatite containing about 0.2% combined Ni.--Auth.

2-3024. Hayton, J.D. **THE CONSTITUTION OF DAVIDITE:** Econ. Geology, v. 55, no. 5, p. 1030-1038, 7 tables, Aug. 1960, 7 refs.

Analyses are presented of samples of davidite from South Australia and South Africa. Brief reference is made to methods of analysis with comments on the states of oxidation of the components. A basis is suggested for determining the constitution of davidite and several possibilities are discussed. It is concluded that davidite is homogeneous in nature and not heterogeneous as suggested by A.W.G. Whittle in a paper of this title.--Auth.

2-3025. Lynd, Langtry E. **ALTERATION OF ILMENITE:** Econ. Geology, v. 55, no. 5, p. 1064-1068, Aug. 1960, 11 refs.

Discussion of a paper by B.H. Flinter (GeoScience Abstracts 1-1752). The term "hydroilmenite" is less preferable than "altered ilmenite" or "weathered ilmenite." The use of the term "arizonite" for fine-grained but well-crystallized alteration products of ilmenite is unjustified because this type of material is well covered by the term "leucoxene." A brief history of some of the controversial aspects of the ilmenite problem is given and it is concluded that chemical analyses should be given on all titaniferous materials studied; the term "ilmenite" should be qualified by such adjectives as "weathered" where applicable; and the Committee on Publications of the Society of Economic Geologists should review the problem and recommend a uniform system of terminology.--J.A. Chamberlain.

2-3026. Flinter, B.H. **MALAYAN ILMENITE VS. ARIZONITE:** Econ. Geology, v. 55, no. 5, p. 1068-1070, Aug. 1960.

Reply to a discussion by M.D. Karkhanavala (GeoScience Abstracts 1-2836). If "arizonite" is not desirable as a term describing a mixture of iron and titanium oxides, the term "hydroilmenite" should be extended to cover both the amorphous and recrystallized stages of an altered ilmenite. On no account can the term "leucoxene" be applied. Other remarks pertinent to the problem of terminology of ilmenite alteration products are included.--J.A. Chamberlain.

2-3027. Van Loan, Paul R., and E.W. Nuffield. **AN X-RAY STUDY OF ROEMERITE:** Can. Mineralogist, v. 6, pt. 3, p. 348-356, 3 diags., 8 tables, 1959, 16 refs.

Roemerite is triclinic P1 with $\underline{a}$ 6.48, $\underline{b}$ 15.26, $\underline{c}$ 6.27 A, α 90° 04', β 100° 48', γ 85° 28'. The orientation of the structural cell corresponds to Wolfe's normal setting based on the morphology. The cell contains $1[Fe''Fe_2'''(SO_4)_4 \cdot 14H_2O]$. X-ray powder data and a list of associated minerals are included. The paper gives 2 tables for the reorientation of oblique cells to the normal setting.--Auth.

2-3028. Pecora, William T. **COESITE CRATERS AND SPACE GEOLOGY:** GeoTimes, v. 5, no. 2, p. 16-19, 32, 5 illus., Sept. 1960, 11 refs.

Coesite is a high pressure polymorph of silica which until recently was known only from synthetic samples. Its discovery in sheared Coconino sandstone at Meteor Crater, Arizona, and from the Rieskessel caldera in Bavaria, Germany, suggest that coesite may be an "index mineral" for high-velocity impact craters or, essentially, meteor craters.--M. Russell.

2-3029. Fahey, Joseph J., Malcolm Ross, and Joseph M. Axelrod. **LOUGHLINITE, A NEW HYDROUS SODIUM MAGNESIUM SILICATE:** Keystone Newsletter, v. 9, no. 10, p. 6-7, Oct. 1960.

Loughlinite is a pearly, fibrous, hydrous sodium magnesium mineral announced in 1948. Its physical properties include sp. gr.=2.165, $\alpha = 1.500$, $\beta = 1.505$, $\gamma = 1.525$, $2V = +60°$, parallel extinction, and positive elongation.--M. Russell.

2-3030. Furcron, A.S. **KYANITE, SILLIMANITE AND ANDALUSITE IN GEORGIA:** Georgia Mineral Newsletter, v. 13, no. 1, p. 9-21, 11 illus., Spring 1960, 37 refs.

Detailed mineralogical descriptions of kyanite, sillimanite, and andalusite are given separately, together with geologic and geographic occurrences. Kyanite deposits occur in Habersham, Rabun, Talbot, Upson, Dawson, Fulton, Cobb, Fannin, Pickens, Cherokee, Lincoln, Banks, and Wilkes counties and generally occur in medium grade metasediments or as residual crystals and nodules derived from the weathering of sillimanite-biotite schists. The andalusite occurs as nodules and porphyroblasts from migmatized schists.-- J.G. Lester.

2-3031. Moore, John E. **AN ANALYSIS OF CLAY MINERALOGY PROBLEMS IN OIL RECOVERY:** Petroleum Engineer, v. 32, no. 2, p. B-40 - B-48, Feb. 1960; no. 3, p. B-78 - B-101, March 1960, 17 figs., 63 refs.

A 2-part report concerning the clay mineral content of petroleum reservoir sands. The most important clay minerals of interest to the petroleum geologist and engineer are the kaolinite, montmorillonite, illite, and mixed lattice minerals because of their characteristic banding of tetrahedral and octahedral sheets. Each mineral actually is a group, with members of each group showing different properties, such as base exchange, clay-water properties, flocculation-defloccuation, and adsorption of organic compounds. A detailed account of the origin and occurrence of clay minerals is beyond the scope of this paper except for that which is related to the accumulation and production of petroleum. The minerals may undergo post-depositional alteration during accumulation that tends to produce a mineral assemblage more in equilibrium with the new environment. The factors of primary importance controlling the clay-mineral composition appear to be: relationship with the rock-forming minerals and solutions in the environment of deposition, and such post-depositional changes as diagenesis, compaction, and lithification.

Clay minerals found associated with oil and gas sandstone reservoirs were either deposited intermixed with the sand grains at approximately the same time as the sand particles, or formed in situ by diagenetic or post-depositional alteration. Size of the clay mineral particles determines the effective porosity of sandstones; the smaller the particle size the greater their effect on porosity. Clay content of sandstones and shales shows a contrast by mineral group that is the result of contrasting permeabilities and changes in the composition of the formation fluid. It also contributes to an increase in the hydrophilic wettability of the sand. If the sand bodies contain appreciable amounts of clay minerals, they may be compressed by overburden pressures.

The clay-mineral content in reservoir sand pore space, due to its intimate association with formatio water and petroleum, has a very significant influen on the character of the reservoir.

Recent advances in the methods used to study cla minerals have provided techniques by which the be- havior of clays and their determination of reservoi characteristics may be determined and predicted.-- T.C. McLean.

2-3032. Hurst, Vernon J. **THE GEOLOGY AND MINERALOGY OF GRAVES MOUNTAIN, GEORGIA:** Georgia, Dept. Mines, Mining & Geology, Bull. no. 68, 33 p., 9 illus., 2 maps, (geol. map in pocket), 7 diags., 2 tables, 1959, 25 refs.

The Graves Mountain area is underlain by a thick sequence of metamorphosed volcanic and sedimentary rocks equivalent to the Slate belt in North and South Carolina. The mountain itself is a ridge of sericite-kyanite-quartz rock, formerly called quar ite, and quartz conglomerate, and is bounded by quartz-sericite schist.

Coarse kyanite, pyrophyllite, rutile, and lazulites are found in a narrow zone striking N. 40°E. diagonally across the mountain. Nine other minerals are recognized, 5 of which - alunite, andalusite, gibbsit kaolinite, and paragonite - have not been previously reported from this locality.

The present mineralogy is a result of several developmental stages whose sequence is revealed by textural and structural relations. Interpreting the mineral assemblages and their sequence in the light of the published P-T-X data, it is concluded that the kyanite probably grew under water-deficient conditions at 400-500°C. and high pressure and that the pyrophyllite formed during ingress of water vapor along fractures as the rocks began to cool.--Auth.

2-3033. Bullock, Kenneth C., and others. **MINERALS AND MINERAL LOCALITIES OF UTAH:** 170 p. maps, The Author, Dept. of Geology, Brigham Youn University, Provo, Utah, 1960, 13 refs.

This guide for mineralogists and rockhounds consists of a list of mineral localities alphabetically by county, then an alphabetical listing of minerals in which each mineral is described and its geologic occurrence and geographical location given.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Stratigraphy 2-2863, 2-2864; Geochemistry 2-3005.

2-3034. Turner, Francis J., and John Verhoogen. **IGNEOUS AND METAMORPHIC PETROLOGY:** 2d ed., 695 p., 117 figs. incl. maps, diags., graphs, tables, New York, McGraw-Hill, 1960, refs.

This book is intended for the use of advanced students, research workers, and teachers in the field of petrology. Its aim is to present a unified general impression of the origin and evolution of rocks that are generally believed to have crystallized, or to have been profoundly modified, at high temperatures and at pressures such as prevail from the earth's surface to a depth of perhaps 20 km.

The science of petrology is underlain by chemical and physical foundations. Many of the most important advances in petrology during the past half century are the result of laboratory experiments of a physic or chemical nature, especially of investigation of phase relationships in various chemical systems (particularly in silicate systems) under controlled conditions. Modern petrological literature abounds in references to the concepts of equilibrium and stability, kinetics of chemical reaction, mechanism of diffusion of matter in and between various media, and to allied topics in the realm of physical chemistry. Considerable space, therefore, has been devoted to such fundamental principles, treated mainl from the thermodynamic standpoint. The authors believe that the quantitative physicochemical approa is justified on the ground that discussion of most problems of petrogenesis is possibly only in the light of some understanding of the complex behavior of multicomponent systems under a wide range of physical conditions.

No attempt has been made to compile comprehensive bibliographies. Footnote references are given, for the most part, to illustrative papers written in English and published within the last 2 or 3 decades. --From auth. pref.

The second edition is largely rewritten and includes recent developments in experimental petrology and geochemistry. The 24 chapters cover the following subjects: principles of chemical equilibrium applied to rocks; characteristics and classification of igneous rocks; variation in associated igneous rocks; crystallization of igneous minerals from silicate melts; crystallization of basaltic and granitic magmas in the light of experimental data; the alkaline olivine-basalt volcanic association; tholeiitic flood basalts and intrusive quartz diabases; potash-rich volcanic rocks and the lamprophyres; volcanic associations of orogenic regions; basic and ultrabasic plutonic associations; the granite granodiorite plutonic association; nepheline syenites, ijolites, and carbonatites; pegmatites; environment, origin, and evolution of magmas; scope of metamorphism and classification of metamorphic rocks; chemical principles of metamorphism; metamorphic zones and metamorphic facies; facies of contact metamorphism; facies of regional metamorphism; chemical changes accompanying metamorphism; the fabric of metamorphic rocks; special features of fabric of deformed rocks; metamorphism in relation to magma and to orogeny.

2-3035. Eaton, Jerry P., and K.J. Murata. HOW VOLCANOES GROW: Science, v. 132, no. 3432, p. 925-938, 8 illus., 2 maps, sec., diag., table, Oct. 7, 1960, approx. 30 refs.

Hawaiian volcanoes offer an unmatched opportunity for studying the mechanism of eruptions and the differentiation of primitive tholeiitic basaltic magma. They are located near the center of the Pacific basin, more than 2,000 mi. from the nearest region of active tectonism, and the story of their origin and continuing activity is one of pure volcanism. Because their lavas experience a minimal exposure to contamination by heterogeneous crustal rocks as they rise to the surface, fractional crystallization plays the dominant role in producing changes in the chemical composition of the lavas extruded at different stages in the life cycle of the volcanoes.

The enormous size, relatively simple structure, and frequent voluminous eruptions of Hawaiian volcanoes all permit the effective use of seismographs and tiltmeters in delineating their internal structure and in detecting the movement and accumulation of magma within them. Other more general geophysical investigations of the Pacific crust and the mantle below provide additional evidence on where Hawaiian magma originates and how it is driven to the surface.

The ultimate cause of volcanism is the fundamental instability of the crust and upper mantle of the earth. About 60 km. beneath the Pacific, the rocks of the mantle yield a fluid fraction with the composition of tholeiitic basalt. The density of this basaltic magma fraction is less than the average density of the 50 km. of mantle (peridotite?), 5 km. of basaltic crust, and 5 km. of water that lie above it, and if the opportunity arises it can be squeezed to the surface by the weight of the material above. The fundamental fracture beneath the Hawaiian ridge has tapped this source of magma and provides the avenue through which it can escape to the surface.

Lava rising through the fundamental fracture beneath Kilauea accumulates slowly in a shallow reservoir only a few kilometers beneath the caldera. At irregular intervals dikes project upward from the expanding reservoir, and if the expansion and consequent pressure within the reservoir are great enough, the dikes break through to the surface and discharge the accumulated lava in an eruption.

Geochemical studies show that while the volcanoes are vigorously active, the most striking variation in their lavas is the content of olivine. Rapid delivery of magma to the surface permits only slight cooling underground, and the only mineral that is fractionally crystallized in significant amounts is olivine, which is depleted from some flows and concentrated in others. When activity declines and magma wells up from depth much less rapidly, it remains in the shallow reservoirs for increasingly longer periods of time. Here the magma cools so slowly through the temperature range in which pyroxene crystallizes that this mineral, as well as the early-formed olivine, settles out of the melt and is immobilized on the floor of the reservoir. Such separation of pyroxene "desilicates" the tholeiitic parent magma and changes its composition to that of alkalic basalt, the predominant lava of the declining stage of Hawaiian volcanism. The temperature, composition, and rate of ascent of the basaltic magma to the surface, therefore, are closely interrelated, and the study of the complex interrelationships of these geophysical and geochemical factors constitutes the fascinating work of observing how volcanoes grow.--Auth. summ.

2-3036. Heinrich, E. Wm. SPHENE-ALLANITE PEGMATITES OF GRIFFITH TOWNSHIP, RENFREW COUNTY, ONTARIO: Can. Mineralogist, v. 6, pt. 3, p. 339-347, 2 tables, 1959, 16 refs.

Small pegmatites in Griffith Township, Ontario, contain chiefly quartz, microcline, plagioclase, pyroxene, and sphene, and accessory hornblende, biotite, apatite, allanite, zircon, scapolite, chlorite, calcite, pyrite, and molybdenite. The dikes are weakly to moderately radioactive, which stems chiefly from the sphene and allanite and to a lesser extent from the apatite and zircon. Paragenetic relations indicate that microcline began to crystallize first and that most of the augite is relatively late. The pegmatites are also geochemically peculiar, both in the abundance of Ca-bearing minerals they contain despite their general granitic character, and their content of accessory elements, Ti, Ce, PO_4, and CO_3. They differ from other well-known sphene-bearing dikes in the region in the near-absence of zircon and the relative abundance of allanite.--Auth.

2-3037. Saha, Ajit Kumar. DECREPITOMETRIC STUDIES ON SOME GRANITES AND PARAGNEISSES FROM SOUTHEASTERN ONTARIO; Can. Mineralogist, v. 6, pt. 3, p. 357-362, graph, 3 tables, 1959, 7 refs.

Samples of granite from Wollaston and Chandos Lake plutons and of associated paragneiss and granitized paragneiss show, on heating, complex decrepigraphs. Of the several observed stages of decrepitation, believed to be due to misfit of solid inclusions, the highest temperature stage was taken to represent the temperature of formation of the rocks (uncorrected for pressure). The average temperatures of formation are 680°C. (Wollaston granite), 657°C. (biotite paragneiss), and 710°C. (Chandos Lake granite, and syenite). The peak heights of the anomalous stage of decrepitation (410°-480°C.) are suggested as a criterion for distinguishing certain metasomatic granites from magmatic granites.--Auth.

2-3038. Hess, H.H. **STILLWATER IGNEOUS COMPLEX, MONTANA, A QUANTITATIVE MINERALOGICAL STUDY.** With an Appendix by J.R. Smith on Optical Properties of Low-Temperature Plagioclase: Geol. Soc. America, Mem. 80, 230 p., 12 pls. (6 in pocket, incl. 2 maps, 2 diags.), 42 figs. incl. maps, secs., diags., graphs, 55 tables, 1960, 133 refs.

The Stillwater igneous complex of Montana is an intrusion of lopolithic form. The floor and about 16,000 ft. of layered rocks are exposed on the E. Boulder plateau. It is estimated that another 40% of the complex and its roof are hidden beneath a cover of Paleozoic rocks. N. of the complex some Precambrian roof rocks are exposed by faulting and erosion.

The order in which the essential minerals separated from the Stillwater magma is as follows: olivine, orthopyroxene, plagioclase, and clinopyroxene. Near the uppermost outcrops hypersthene inverted from pigeonite appears. The only other mineral present in rock-forming amount is the accessory, chromite, which is concentrated in a few layers in the lower part of the complex. The complex represents a natural example of fractional crystallization on a vast scale. Crystals separate from the magma and accumulate on the floor only to be covered by more precipitate which thereby prevents reaction with the remaining liquid.

The chemistry of the essential minerals - plagioclase, orthopyroxene, and clinopyroxene - is thoroughly investigated. New optical-property curves are presented, and the accuracy and suitability of various determinative procedures are discussed. Smith's curves for low-temperature plagioclase represent a marked improvement over existing curves, and his determinative procedure is an advance both in precision and ease of measurement. The exsolution phenomena in the pyroxenes are used to interpret the subsolid relationships and to draw petrologic conclusions particularly as regards temperature during crystallization.

Curves are drawn to show the order in which the essential minerals separated from magma and their composition changes as crystallization proceeded. The general trend of the curves from more magnesian to more Fe-rich for the ferromagnesian minerals and from more calcic to more sodic for the plagioclases is evident. Of particular interest are the minor oscillations of these curves. These can be correlated with the effect of pore-space liquid on the accumulated crystals on the floor. The pore space in the crystal mush is at least 25% by volume. The effect produced by this pore-space liquid is very much less than what would be expected; consequently it is postulated that diffusion from the pore-space liquid to the overlying main mass of magma and vice versa has tended to diminish the effect. When accumulation of crystals on the floor is slow, diffusion may be so effective that the phases formed will not be appreciably different in composition from the accumulated crystals; when accumulation is rapid, the pore-space liquid can have a large effect in modifying the composition of the crystals formed. Phases present in small amount among the accumulated crystals can be modified to a greater extent by pore-space liquid, and phases present in large amount are modified to a lesser extent. At any rate minor fluctuations in the mineral-variation curves can be correlated with the local rate of accumulation of crystals on the floor. The process also accounts for th formation of certain monomineralic rocks. Withou diffusion the trapped pore-space liquid would have contributed small amounts of other phases to the rocks.

With respect to layering in the Stillwater comple both the observations and conclusions closely paral lel those of Wager and Deer for the Skaergaard intrusion. A theory to account for rhythmic layering is advanced. If crystals with different settling velo ities are present and if the magma is in motion, rhythmic layering will result provided the vertical component of the motion in the magma is not consta Velocities such as 100 m /yr. are of the right orde to produce the desired result if the viscosity is 3,00 poises. Well-developed rhythmic layering, howeve is almost always associated with very large differences in settling velocities between phases. Thus i is conspicuously developed in the Stillwater comple norite zone, where the orthopyroxene crystals are comparatively large and plagioclase comparatively small. The settling velocity difference is 25 to 1. This suggests that the process operates in a layer of magma very close to the floor, perhaps in the low 100 m.

The composition of the magma is estimated from the composition of the border facies. It is very similar to the Bushveld complex. It is a basaltic magm just saturated, and is comparatively low in TiO_2, Fe_2O_3, and K_2O. Otherwise it is much like the Karroo dolerites or Palisades diabase. An estimate of the composition of the hidden uppermost rocks is made by subtracting the composition of the exposed complex from the original magma in suitable propor tions. If 40% is hidden, the resulting composition by subtraction is such that it corresponds to rocks of the uppermost portion of the Bushveld complex or Great Dyke - ferrogabbro.

An estimate of the rate of heat loss during crystallization suggests that about 10 cm. of crystals are deposited on the floor a year. If the roof is muc thicker than 1 km. this value may have to be reduce Data on viscosity of basalts, densities of phases at high temperatures, and settling rates of crystals are analyzed. It is shown that 2-phase convection in the magma is probable.

In appendices certain general propositions are discussed. The calc-alkaline magma series so differs in its trends from those produced by fractional crystallization that some other origin seems require A partial melting sequence is suggested. This leads to a consideration of the generation of magmas and the vertical composition gradient in continental crus Differentiation of dolerite sills parallels the trend observed in the Stillwater complex but with a lower degree of fractionation. Absence of igneous lamination suggests that the process is unrelated to crysta settling. A process of inward crystallization from cooling surfaces analogous to the crystallization of the pore-space liquid in the Stillwater crystal mush is suggested; a diffusion mechanism removes the film of residual liquid.--Auth.

2-3039. Lydon, Philip A. **GEOLOGICAL SECTIO AND PETROGRAPHY ALONG THE POE TUNNEL, BUTTE COUNTY, CALIFORNIA:** California, Div. Mines, Spec. Rept. 61, 18 p., 15 illus., 3 maps, (incl. geol. map, sec. in pocket, scale 1:18,000), diag., graph, 1959, 11 refs.

More than 6 mi. of a sequence of serpentine and metamorphic rocks of presumed Paleozoic age are penetrated by the Poe tunnel in the western foothills of the northern Sierra Nevada. About 60% of the tunnel length is in serpentine, 35% in undifferentiated metamorphic rocks (biotite-hornblende schist, greenschist, high-grade pelitic schist, quartzite, and amphibolites derived from sedimentary and basic igneous rocks), 5% in metagabbro, and less than 1% in granodiorite, limestone, and blastoporphyritic amphibolite. The petrography of each of these rock types is described.

Mineralogical variation in rocks near the contact of granodiorite with biotite schist suggest that the granodiorite might have been derived from a dioritic magma by a process involving differentiation of plagioclase and hornblende, and introduction of silica. Metamorphic rocks penetrated by the Poe tunnel were produced by low-grade regional metamorphism, modified locally to a relatively slight degree by later igneous intrusion and hydrothermal alteration.

Geological factors such as closely spaced joints, shear zones, and flows of water slowed the rate of tunnel advance. The relationship between local geological features, rock type, rate of tunneling, and support required is graphed for 1,000 ft. of the tunnel.--Auth.

2-3040. Overstreet, William C., and Henry Bell. NOTES ON THE KINGS MOUNTAIN BELT IN LAURENS COUNTY, SOUTH CAROLINA: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 4, p. 27-30, fold. map, July-Aug. 1960, 4 refs.

A belt of phyllite and schist 2 to 4 mi. wide strikes southwestward across Laurens County, South Carolina, and lies between Laurens and Clinton. The belt includes a well-defined Mn-rich unit, and its gross lithology is strikingly like the Battleground schist of Precambrian(?) or Paleozoic(?) age in Cherokee and York counties. Regional metamorphic isograds cross the strike of the belt with the result that the metamorphic grade of the rocks increases from greenschist facies in the northern part of the county to upper amphibolite facies in the southwestern part of the county. Farther southwestward the metamorphic grade declines, and at the Georgia state line the belt of rocks is at the greenschist facies. Similar discordances between metamorphic grade and stratigraphic trends may explain the apparent disappearance of other belts of low-rank metamorphic rocks elsewhere in the Piedmont.--Auth.

10. SEDIMENTARY PETROLOGY

See also: Geomorphology 2-2826; Stratigraphy 2-2852; Paleontology 2-2914; Mineralogy 2-3016, 2-3021, 2-3031; Mineral Deposits 2-3101; Fuels 2-3114.

2-3041. Pantin, H.M. DYE-STAINING TECHNIQUE FOR EXAMINATION OF SEDIMENTARY MICROSTRUCTURES IN CORES: Jour. Sed. Petrology, v. 30, no. 2, p. 314-316, 6 illus., table, June 1960, ref.

A dye-staining technique is described that is capable of producing a high visible contrast between different lithologies in core-samples; this enables microstructures in the sediment to be clearly identified and illustrated.--Auth.

2-3042. Griffiths, John C. FREQUENCY DISTRIBUTIONS IN ACCESSORY MINERAL ANALYSIS: Jour. Geology, v. 68, no. 4, p. 353-365, diag., 8 tables, July 1960, 19 refs.

Counts to determine the frequency distributions of the occurrence of accessory heavy minerals in sediments may lead to binomial, Poisson, or negative binomial distributions; and conditions leading to those distributions are discussed. A set of data may be "fitted" to these model distributions, and the goodness of fit may be tested by chi-square. An example of fitting the Poisson, mixed Poisson, and negative binomial to some estimates of the frequency of zircon in some samples of Oswego sandstone from a single outcrop is described; the lack of fit appears to be due to nonrandom variation among operator-sample pairs.--Auth.

2-3043. Evans, James R. GRAIN SIZE OF FRAGMENTAL SEDIMENTARY ROCKS: California, Div. Mines, Mineral Inf. Service, v. 13, no. 9, p. 1-8, 3 figs. incl. illus., diags., 2 tables, Sept. 1960, 22 refs.

A brief and nontechnical discussion of the particle size features of fragmental sediments and sedimentary rocks and their application to geologic and engineering problems.

In large part, size is the key to the classification of fragmental rocks. In addition to the size of particles, geologists and engineers record their shape and arrangement. These 3 constitute the textural features of a sediment or sedimentary rock. It is most difficult to apply a single technique of size to a sample containing particles in a wide range of sizes. Screening with sieves, methods based on settling velocity of grains, and direct measurement of grains are common techniques used to measure size. Most methods of size measurement are based on the assumption that the particles measured are spherical in shape. Few, if any particles are spheres, and measurement methods are somewhat limited because they do not allow for irregularity of shape. The size distribution of a sample can be shown graphically by means of a histogram, frequence curve, or a cumulative curve.

Of the many grade scales devised, 10 are compared and contrasted in tabular form, set up to provide ready conversion from one scale to another. Each scale differs from the other in some respect and in theory meets a specific need of the engineer or geologist. Any scale desired can be used as long as the meaning as to size is clear. A knowledge of the size, shape, and arrangement features of fragmental rocks is useful to the geologist and engineer because it 1) provides clues to the conditions under which these materials were transported and deposited; 2) shows that grain size is related to mineral composition and density; 3) aids in the evaluation of commercial sand and gravel deposits for use as construction materials, and permits a determination of the proper blends of such materials; 4) shows that maximum grain size, and the distribution of different sized particles, in large part, control the porosity and permeability of these natural materials. --Auth.

2-3044. Rolfe, Bernard N., R.F. Miller, and Irel S. McQueen. DISPERSION CHARACTERISTICS OF MONTMORILLONITE, KAOLINITE, AND ILLITE CLAYS IN WATERS OF VARYING QUALITY, AND THEIR CONTROL WITH PHOSPHATE DISPERSANTS: U.S. Geol. Survey, Prof. Paper 334-G, p. 229-273, 18 diags., 20 tables, 1960, 17 refs.

This study is concerned with the dispersion characteristics of montmorillonite, kaolinite, and illite clay minerals in waters of different hardness and the relation of these characteristics to the control of canal seepage by artificial sedimentation. The effect of dehydrated sodium phosphates on dispersion was also investigated. The importance of recognizing colloidal suspensions as ternary systems (colloid, water, ionized salt) is emphasized.

Representative samples of montmorillonite, kaolinite, and illite clays, were saturated with either Ca or Na and then prepared as 1% suspensions in distilled, hard, and soft waters. This provided extreme clay-water environments with respect to an investigation of the control of dispersion through the injection of sodium polyphosphate-type dispersants. Intermediate conditions were also provided by using a water of intermediate quality between hard and soft extremes. A native montmorillonite clay was selected for use as the prototype of Ca-Na exchange relation and was replicated on the kaolinite and illite clays. The dispersion characteristics of the clay minerals under the preceding environments are involved in sediment transport in natural streams and play a decisive role in sediment-lining procedures. The deflocculents used in the investigation were sodium tripolyphosphate ($Na_5P_3O_{10}$), tetrasodium pyrophosphate ($Na_4P_2O_7$), sodium hexametaphosphate $(NaPO_3)_n$, and sodium hexametaphosphate plus soda ash (Na_2CO_3) in a 50-50 by weight mixture. The deflocculents varied in dispersion efficiency depending upon the interaction of the clay-water-phosphate systems. These variations were related to dissociation of Na and length of polymer chains. A specific deflocculent for each clay, water, ionized salt system was indicated by the data.

The percentage of dispersion was measured by sensitive hydrometers, reading from 0-10 grams of colloid per liter. This instrument gave generally acceptable results, except where conditions did not conform to the limitations imposed by basic theories of hydrometer analysis. The greatest source of trouble was in montmorillonite suspensions which produced anomalous increases in the hydrometer readings. This was attributed to consolidation of uniformly sized particles in the hydrometer jar, producing a greater apparent specific gravity in the zone measured by the hydrometer. The increase was usually accompanied by phenomena similar to gelation.

As an aid in comparing the many hydrometer analyses (consisting of 3,156 hydrometer readings), the index of dispersion concept was introduced. This value totals selected ordinates under a dispersion curve and compares the sum to a base value obtained by the same method for selected ordinates under a standard curve representing Na-saturated clays in distilled water. Thus, for each clay mineral there is a standard value against which all deflocculating treatments may be compared.

The results indicate the importance of understanding the chemistry of the ternary system (clay, water, ionized salt). The dependence of dispersion on the interaction of these 3 factors is great. Each clay-mineral group has specific properties and characteristics in the system. Not only does montmorillonite show the greatest colloidal yield but it is the most responsive to changes in chemical environment. It is far more difficult to Na saturate a Ca clay than a hard Ca water. Although replusion between like negative surfaces is the basis of dispersion, the location, source, and amount of negativity of the various clay minerals determine the best deflocculent for effecting dispersion.

The general implications of the study have a bearing on several fields of sedimentation. With respect to sediment lining of canals, the investigation indicated the relative superiority of montmorillonite-type clays for the penetration and filling of small voids. With respect to filling of joints, cracks, burrows, and other relatively large openings, kaolinite and illite clays may be suitable as mortaring agents. --Auth.

2-3045. Weiss, Malcolm P., and Carl E. Norman. THE AMERICAN UPPER ORDOVICIAN STANDARD. IV. CLASSIFICATION OF THE LIMESTONES OF THE TYPE CINCINNATIAN: Jour. Sed. Petrology, v. 30, no. 2, p. 283-296, 7 illus., 6 diags., 2 tables, June 1960, 11 refs.

The abundant ledges of limestone characteristic of the type Cincinnatian in the Ohio Valley can be grouped into several classes on the basis of a few criteria that are readily recognized in the hand specimen. Such a classification can make rock descriptions much simpler for those who measure sections there; furthermore, closer correspondence is now possible between the rock descriptions used or published by different workers. The petrographic properties of the 7 classes are fully described and illustrated, although the limestone types are readily distinguished as follows: 1) Fabric of whole and broken fossils randomly arranged; insoluble fraction small and localized. 2) Fabric of broken and whole fossils oriented parallel to bedding; insoluble fraction moderate in amount and localized or disseminated. 3) Fabric of whole and broken fossils, either oriented or randomly arranged; insoluble fraction large. 4) Fabric of finely broken fossil debris; insoluble fraction small and disseminated. 5) Fabric of finely broken fossil debris; insoluble fraction moderate to large; rock laminated or cross-laminated. 6) Fabric of very finely broken fossil debris; insoluble fraction large. 7) Like number 6, but occurs as nodules.--Auth.

2-3046. Lattman, Laurence H. CROSS SECTION OF A FLOODPLAIN IN A MOIST REGION OF MODERATE RELIEF: Jour. Sed. Petrology, v. 30, no. 2, p. 275-282, 2 maps, 2 secs., table, June 1960, 5 refs.

The cross section of a small floodplain [Beaverdam Run, Cambria County, Pennsylvania] in the Appalachian Plateau was shown in excavations and borings for a dam. Deposits of vertical accretion, lateral accretion, lag deposits, channel fill, and colluvium fill the valley of an aggrading stream. Colluvium comprises almost 1/5 of the total valley fill and contains isolated lenses of vertical accretion. The colluvium built out from the valley side as the stream shifted laterally across the floodplain. Vertical and lateral accretion deposits may be sharply differentiated where exposed in a trench; the lateral accretion is composed of 70-75% sand size material and the vertical accretion of 35-60% clay size material.--Auth.

2-3047. Daniels, Raymond B., Richard L. Handy, and Gerald H. Simonson. DARK-COLORED BANDS IN THE THICK LOESS OF WESTERN IOWA: Jour. Geology, v. 68, no. 4, p. 450-458, 2 illus., map, 6 secs., July 1960, 8 refs.

Faint to distinct dark-colored bands occur in fres roadcuts throughout a widespread area of thick loess in western Iowa. The bands resemble very weak A-horizons of buried soils, and parallel the underlying geomorphic surfaces. In the western part of the area 2 dark bands are present, but in their extreme eastern distribution the upper band rises in the section and fades into the upper leached zone of the Wisconsin loess.

Chemical studies show a consistent increase of about 0.08% in Mn and less consistent increases of about 0.2% in free Fe, and 0.03% in organic matter in the bands compared to the overlying and underlying loess. The dark color of the bands is mainly due to the higher Mn content. Some leaching of carbonates has occurred in the loess immediately below the basal band.

From the physical and chemical properties of the bands and the relationship to underlying geomorphic surfaces, the bands are believed to represent surfaces of slow or temporary nondeposition of loess. Because of the weak expression, it is questionable whether they represent true interstadial breaks in loess deposition.--Auth.

2-3048. Kulik, N. LIME CONCRETIONS IN SEMIDESERT SOILS: Pochvovedeniye. Soviet Soil Sci., in translation, 1959, no. 1, p. 126, pub. Aug. 1960.

Lime concretions as large as peas in desert pavement areas of the northern Caucasus were formed by the mortaring action of individual rain drops on naturally calcined limestone and rolled into nodules by wind before hardening.--M. Russell.

2-3049. Smith, William O., Carl P. Vetter, G. B. Cummings, and others. COMPREHENSIVE SURVEY OF SEDIMENTATION IN LAKE MEAD, 1948-49: U.S. Geol. Survey, Prof. Paper 295, 254 p., 28 illus. on 17 pls., 12 pls. in pocket incl. 9 maps, graphs, 2 profiles, 65 figs. incl. maps, secs., profiles, diags., graphs, 29 tables, 1960, 127 refs.

This report presents the results of studies of Lake Mead [NW. Arizona, S.E. Nevada] and its environs made in 1948-1949. In the hydrographic survey of the lake, depths were measured by echo sounding. The equipment operating at 50 kilocycles gave a consistent indication of the top of the sediment, with error of less than 2 ft. The instruments operating at 14.25 kilocycles produced an echo from the sediment surface and, where the sediments were dominantly silt and clay of moderate to high water content, produced an echo from the bottom of the old river bed as well. In the Boulder basin, complete penetration of some 140 ft. of soft sediment was obtained.

Area and capacity tables, prepared on the basis of this hydrographic survey, show that the total capacity of the reservoir was reduced 4.9% during the first 14 years after Hoover Dam was completed, but that the usable capacity was reduced only 3.2%. Practically all this reduction was caused by accumulation of sediment in the reservoir. Studies of inflow and outflow indicate that the reservoir has a total storage capacity about 12% greater than that shown by the area-capacity table, because of "bank" storage (ground-water storage) in the bottom and sides of the reservoir. Thus the total capacity in 1949 was greater than the quantity shown by the original 1935 area and capacity table, even though large quantities of sediment had been deposited in the reservoir during the 14 years.

The sediment accumulated in Lake Mead has formed 2 deltas. One extends from Bridge Canyon to Hoover Dam along the thalweg of the Colorado River; the other, of much smaller size, extends along the inundated Virgin River channel. Most of the sediment brought into Lake Mead is supplied by the Colorado River and accumulates in its delta, which thickens progressively from Bridge Canyon to Pierce basin, where it attains a maximum thickness of 270 ft. Topset beds make up the surface of this part of the delta. The foreset beds that make up the delta front in Pierce basin dip sharply beneath the lake surface for a distance of about 1 1/2 mi., measured along the course of the submerged Colorado River channel. From the foot of the delta front to Hoover Dam the slope of the bottomset beds ranges from 9 ft. per mi. between the delta front and the mouth of Iceberg Canyon, to less than 1 ft. per mi. in the southern part of Boulder basin. The bottomset beds in 1948 had a minimum thickness of 45 ft. in the Temple Bar area, increasing progressively to 106 ft. at the dam.

According to computations of the volume and weight of the accumulated sediment, about 2,000 million tons was deposited in the reservoir in 14 years; this is within 2% of the amount calculated from measurements of the suspended sediment carried by the inflowing rivers. It is estimated that the sediment capacity of the reservoir, when filled to the permanent spillway crest, is about 75,000 million tons. This quantity is 37 times as great as the amount which occupied 4.9% of the reservoir capacity in 1948-1949. The prediction is based on estimates that the sediment-storage capacity is about 25% greater than the water-storage capacity, and that the mean specific weight of the sediment will ultimately be nearly 50% greater than in 1948-1949, owing to compaction of the clay and silt. The sediment contributed by the Colorado River averages about 45% sand and 55% silt and clay. Practically all the clay and much of the silt has been transported by turbidity currents into the lowest parts of the reservoir.

The sediment level at the dam will reach the elevation of the lower outlet gates, and the present dead-storage space will be filled when the total accumulation becomes about 7 times as great as the amount brought into the lake from 1935 to 1948. The water-storage capacity below the permanent spillway crest will then be about 22 million acre-ft. This prediction is based on certain assumptions, of which an important one concerns reservoir operation. It is assumed that the average operating level will be at spillway level, 35 ft. higher than at present, and on that assumption it is predicted that approximately 20% of the total sediment load will be deposited above the level of the permanent spillway crest. Lower average operating levels will reduce the proportion of sediment deposited in the upper part of the reservoir, extend the delta front downlake, reduce the area available for deposition of silt and clay, and result in a more rapid rise of the sediment level at the dam.

If the sediment carried by the river in the years 1926-1950 represents the long-term average rate of accumulation in Lake Mead, it will be more than 4 centuries before the reservoir is filled with sediment to the level of the permanent spillway crest. The rate of sedimentation since the first year of Lake Mead (1935) has been about 20% lower than this 25-year average, and if that rate continues in the future, the life of the reservoir will be correspondingly greater. Construction of upstream reservoirs to capture some of the inflowing sediment, or transportation of sediment in the outflow through Hoover Dam, would also increase the life of the reservoir.

The total bacterial population in the sediment near the dam was found to exceed 1 million bacteria per gram at all depths, which is comparable with the bacterial population in raw sewage. Near the mud surface there is a minimum of 10 million bacteria per gram. By contrast, the water less than a foot above the sediment surface contained only 100 bacteria per gram. By comparison with marine and natural lake muds, the Lake Mead sediments are unique in containing a high bacterial population disturbed uniformly throughout a deep and loosely packed layer. Laboratory tests indicate that the abundance and activity of the microflora have contributed to the heating of the fresh sediment layer in Lake Mead, and also that they affect the H-ion concentration of the water in the sediment, which in turn influences the rate of sediment compaction.

In the first 12 years of Lake Mead, the dissolved mineral matter in the outflowing water was significantly greater than the average in the inflowing water, owing in part to solution of gypsum and rock salt from the bed of the reservoir. Currently the increased dissolved solids in the outflowing water can be accounted for almost entirely by evaporation from the reservoir, which is about 5 to 7% of the annual inflow. The water from Lake Mead is generally of better quality than the water that was diverted from the river for irrigation prior to regulation by Hoover Dam, because it represents an average of the poor water of low stages and the excellent water from melting snow. Since 1935 the concentration of dissolved solids in the inflow has ranged from 225 to 1,720 parts per million, but in the outflow from Lake Mead the concentration has ranged only from 621 to 824 p.p.m. The "alkali" problem of the areas downstream that are irrigated with the Colorado River water has been decreased to an appreciable extent because of this stabilization.

Oceanographic techniques were utilized to establish the general features of the circulation in Lake Mead. Analysis of the data collected during 12 monthly cruises on Lake Mead indicates a distinct and orderly cyclic progression in the distribution of properties and in the implied circulation, which can be related to the seasonal changes of weather and river inflow.

The changes in elevation measured by precise leveling since 1935 indicate that the weight of water and sediment in the reservoir has caused some subsidence, and that there has also been an extensive tilting subsidence involving the entire lake basin and extending tens of miles farther S. The amount of lowering of bench marks around the reservoir, calculated with respect to a bench mark at Cane Springs, Nevada, has been relatively small. Hoover Dam was lowered about 0.4 ft. between 1935 and 1950, and bench marks along the shores of the Boulder and Virgin basins of the lake (which have 60% of the reservoir storage capacity) have been lowered as much as 0.6 ft. On the other hand, bench marks near the Overton Arm and E. of Virgin Canyon have not dropped as much as those near the dam. It is concluded that the differential subsidence has not changed the reservoir capacity appreciably.

Since 1941 there has been more subsidence at the dam than at any of the 6 locations - where the level net provides data as to elevations - near the shore of the reservoir. The leveling operation of 1941 was performed while the reservoir was filled nearly to capacity, and the differential rise at these 6 locations by 1950 may be indication of elastic rebound with reduced load.

Lake Mead had a noteworthy predecessor in the geologic past. The Colorado River was dammed during the Pleistocene epoch, forming a lake that was deeper and more extensive than Lake Mead, in which there was delta deposition similar to that which has begun since the completion of Hoover Dam. The lower part of the Chemehuevi formation (deposited in that lake) consists chiefly of banded clay, presumably deposited as bottomset beds in a deep lake. This clay is thin in Iceberg Canyon and thicker downstream; extensive remnants occur near Davis Dam, about 60 mi. below Hoover Dam. Sand overlies the clay and composes most of the thickness of the formation in upstream areas. The upper part of the formation consists of river gravel and cobbles, presumably deposited after the lake was filled with fine sediment. Some of these gravels are about 300 ft. above the high-water level of Lake Mead. The cobbles in the upper part of the Chemehuevi formation were transported by a larger and more powerful stream than the present Colorado River, which apparently carries nothing coarser than fine gravel into the deltaic fill in the Lower Granite Gorge.--Auth.

2-3050. Hadley, Richard F. **RECENT SEDIMENTATION AND EROSIONAL HISTORY OF FIVEMILE CREEK, FREMONT COUNTY, WYOMING:** U.S. Geol. Survey, Prof. Paper 352-A, 16 p., 5 illus., 3 maps (2 in pocket, incl. geol. map, scale 1:12,000), sec., 4 diags., profile, 5 tables, 1960, 40 refs.

A study of the terrace sequence was made along Fivemile Creek. Three terraces and the modern flood plain border the present stream; the highest (terrace 3) is a gravel-capped, rock-cut surface and the lower 2 (terraces 1 and 2) are composed of alluvium. The 3 terraces and flood plain stand about 28, 18, 9, and 3 ft. above the present stream.

The alluvium underlying the flood plain and terraces 1 and 2 and the gravels of terrace 3 were sampled for laboratory study. Textural analysis of terrace 1 alluvium showed a normal decrease in median diameter in a downstream direction, ranging from 0.185 to 0.123 mm. near the mouth of the stream. Terrace 2 alluvium showed very little change of median grain size in the 55-mi. length of the terrace; the median diameter ranging from 0.017 to 0.023 mm. Samples of flood-plain alluvium were highly variable in texture. Studies of roundness and sphericity of terrace 3 gravels in the 16-32 mm. size range show that values of both indexes increase markedly from the head to the mouth of the valley. Roundness is also affected by mineral composition. The heavy-mineral suites from terraces 1 and 2 alluvium showed some marked differences in mineral content.

Terraces on Wind River which are correlative of terrace 3 have been traced to glacial moraines in the Wind River Mountains. Therefore, development of the terrace sequence on Fivemile Creek began in late Wisconsin time. No satisfactory evidence such as archeological sites or vertebrate remains were found by which terraces 1 and 2 could be dated. Historical evidence shows, however, that the latest trenching of the valley and formation of the modern flood plain has occurred since 1920. Measurements of aggradation of flood plains in historical time and other evidence indicate a probable rapid rate of accumulation of alluvial deposits.--Auth.

2-3051. Moore, Derek. **SEDIMENTATION UNITS IN SANDSTONES OF THE YOREDALE SERIES (LOWER CARBONIFEROUS) OF YORKSHIRE, ENGLAND:** Jour. Sed. Petrology, v. 30, no. 2, p. 218-227, map, 2 secs., 8 diags., table, June 1960, 16 refs.

The typical sandstone of the cyclothems of the

Yoredale series is a sheet sandstone which consists of a number of tongues of massive, cross-bedded sandstone lying on more continuous flaggy sandstone into which they pass laterally. Each tongue of massive sandstone has its origin in the bank of a channel sandstone, and the radially distributed cross-bedding of the massive sandstone can be used to locate the point of origin.

Local relief existing before sandstone deposition and that created by sandstone deposition can be demonstrated. The latter often was sufficiently pronounced to cause emergence of the surface of the sheet sandstone. The emergence is revealed by the occurrence of seat-earths, coals, and sandy patches in the overlying thin limestones.

The features described compare so closely with crevasse deposits in the Mississippi delta that there can be no doubt of their deltaic origin.--Auth.

2-3052. Allen, J.R.L. THE MAM TOR SANDSTONES: A "TURBIDITE" FACIES OF THE NAMURIAN DELTAS OF DERBYSHIRE, ENGLAND: Jour. Sed. Petrology, v. 30, no. 2, p. 193-208, 6 illus., 2 secs., 4 diags., June 1960, 44 refs.

The Kinderscoutian Mam Tor sandstones (400 ft. thick [upper Carboniferous]) at Mam Tor, Derbyshire, are formed by a monotonously repeated cyclothem (sandstone-shale group) in which grain size diminishes upwards from the base. Shales, mudstones, siltstones, sandstones (laminated and nonlaminated), and shale conglomerates and breccias are the chief rock types present. The sandstones are ill-sorted, bearing detrital clay matrices and some plant debris. Marine pelecypods occur in the shales. The sandstone-shale groups are widely persistent laterally and on their sharp soles bear groove casts, flute casts, load casts, sludge casts, and trail casts. Convolute bedding, corrugated bedding, crumpled bedding, and slump-ball structures are often found.

The Mam Tor sandstones, derived from sources which included metasedimentary and granitic rocks, were probably deposited in deep quiet waters by currents which at first flowed along roughly E.-W. lines and later, more importantly, flowed southwards. In the mid-Pennines the Mam Tor sandstones pass into coarse sandstones bearing coals. These, of the same age as the Mam Tor rocks, were deposited also by mainly southerly currents, apparently in the shallow water environments of a delta complex. The Mam Tor sandstones are suggested to be the deposits of turbidity currents which may have originated in slumps of the shallower delta sediments coexisting higher on the submarine slopes.--Auth.

2-3053. Packham, G.H., and Keith A.W. Crook. THE PRINCIPLE OF DIAGENETIC FACIES AND SOME OF ITS IMPLICATIONS: Jour. Geology, v. 68, no. 4, p. 392-407, 2 figs., 4 tables, July 1960, 38 refs.

Chemical reorganization occurs during diagenesis as a response of a rock to its physicochemical environment. The mineral assemblages produced will be dependent on the environment and the materials present. Physiochemical factors of importance in diagenesis appear to be environmental pH-cation concentration, environmental Eh, pressure, and temperature.

Mineral assemblages which can be expected to appear in given rocks under given conditions can be inferred from data derived from inherent properties of minerals, such as abrasion pH, from laboratory studies on mineral stability fields and hydrothermal alteration, from theoretical studies on mineral stabilities, from hydrothermal deposits, and from diagenetic depth sequences.

These data suggest the possibility of erecting a sequence of facies, analogous to metamorphic facies, starting at the surface and passing down into the low-grade metamorphic facies. Each diagenetic facies can be defined as including all rocks or sedimentary detritus which have, by a process of diagenesis, developed mineral assemblages that are the result of adjustment to a particular diagenetic environment. The concept of equilibrium cannot be universally applied because metastable minerals are characteristically present in some assemblages.

Teodorovich has erected 13 "facies" (here termed "parfacies"), representative of halmyrolosis and early diagenesis, which constitute a low-rank facies of diagenesis. Satisfactory definition of higher-ranking facies is not yet possible, but facies characterized, with increasing rank, by heulandite-analcite, laumontite, prehnite-pumpellyite, and albite-epidote may be recognizable in rocks of suitable composition modified under alkaline conditions. Variations of assemblage with composition and pH are not satisfactorily known. However, kaolinite will become important as pH decreases.--Auth.

2-3054. Cummings, David. THE BASAL CHEPULTEPEC SANDSTONE (CAMBRIAN-ORDOVICIAN BOUNDARY) IN THE RIDGE AND VALLEY PROVINCE OF TENNESSEE: Jour. Sed. Petrology, v. 30, no. 2, p. 228-240, 4 maps, sec., 5 tables, June 1960, 12 refs.

Examination of the well-sorted quartzose sandstone indicates a decrease in grain size as well as a diminution of heavy minerals to the E. and SE. Characteristic heavy mineral suites from the 3 fundamental types of source rock occur in the sandstone. Their areal distribution suggests a provenance to the N. and NW.--Auth.

2-3055. Siegel, Frederic R. THE EFFECT OF STRONTIUM ON THE ARAGONITE-CALCITE RATIOS OF PLEISTOCENE CORALS: Jour. Sed. Petrology, v. 30, no. 2, p. 297-304, illus., map, diag., 2 tables, June 1960, 11 refs.

The Pleistocene coral reefs which form the upper Florida Keys are in a state of alteration from aragonite to calcite. A quantitative relationship between the Sr content of the corals and their aragonite-calcite ratios was found. Sr and Ca determination were made with a Zeiss flame photometer. Aragonite-calcite ratios were determined qualitatively with Meigen stains and quantitatively using X-ray techniques. Where the stains showed that aragonite was high relative to calcite, the Sr content was correspondingly high. Where the stains indicated that calcite was dominant, the Sr content was low. X-ray analyses confirmed these results. In several cases it was noted that within a single sample there were distinct areas which were aragonite and others which were calcite. These sections were separated and analyzed. In all such cases the aragonite portion of a sample contained about twice as much Sr as did the calcite portion of the same sample. It is suggested that Sr content is a factor which inhibits the alteration of aragonite to calcite under natural geologic conditions, and only when much of the Sr is removed may the alteration take place.--Auth.

2-3056. Carozzi, Albert V., and John B. Hunt. FORE-REEF PETROGRAPHY OF THE SILURIAN RICHVALLEY REEF, INDIANA: Jour. Sed. Petrology, v. 30, no. 2, p. 209-217, 5 diags., table, June 1960, 6 refs.

The microscopic investigation of the inclined fore-reef beds of the Silurian Richvalley reef (developed in the Liston Creek formation) reveals that they consist of 5 microfacies. These appear today through the effect of dolomitization as argillaceous dolomites, dolomites, dolomitic calcarenites, and calcarenites; however, they all were originally calcarenites.

The statistical investigation of the detrital quartz, the echinoderm fragments, and the general organic frequency allows a bathymetrical classification of the 5 microfacies indicating that each tongue of fore-reef clastics consists of their juxtaposition in concentric belts. Hence, it is possible to reconstruct the fluctuations of the reef-core margins corresponding to the successive tongues.--Auth.

2-3057. Fessenden, Franklin W. A PETROLOGIC INVESTIGATION OF THE MANLIUS AND COEYMANS LIMESTONES: New York Acad. Sci., Annals, v. 84, art. 8, p. 287-302, 2 maps, sec., graphs, June 1960, 15 refs.

A petrologic investigation consisting of thin section and heavy mineral slide analyses of 94 samples taken across the contact of the Manlius and Coeymans formations leads to the conclusion that the contact is transitional. Continuous deposition is inferred for late Silurian through early Devonian time in the Helderberg area. A concentration of large barite grains in a horizon immediately below the waterlime beds was observed which might, upon further study, yield more information about the nature of the transition zone.--Auth. summ.

2-3058. Heron, S. Duncan, Jr. NOTES ON THE CALCIUM CARBONATE CONTENT OF THE SANTEE LIMESTONE: South Carolina State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 4, p. 31-33, map, July-Aug. 1960, ref.

The Santee limestone (Eocene) occurs near the surface in parts of 8 South Carolina Coastal Plain counties. More than 175 chemical analyses from the outcrop area indicate that the calcium carbonate content is high and relatively uniform over a wide area and through much of the thickness of the formation. Near the top of the formation the carbonate content is highest, averaging near 95% in the Holly Hill-Harleyville area. Impurities in the Santee limestone are mostly quartz and clay. Magnesium carbonate and calcium phosphate are low, usually less than 1 or 2%.--Auth.

2-3059. Gulbrandsen, Robert A., and Earle R. Cressman. ANALCIME AND ALBITE IN ALTERED JURASSIC TUFF IN IDAHO AND WYOMING: Jour. Geology, v. 68, no. 4, p. 458-464, map, table, July 1960, 26 refs.

A Na-rich altered tuff bed, approximately 5 ft. thick, in the Jurassic Twin Creek limestone occurs over an area of more than 1,000 sq. mi. in Idaho and Wyoming. Microcrystalline quartz, analcime, albite, and calcite are the major components of the typically hard pale-green or grayish-green aphanite. One chemically analyzed analcime-rich rock contains 6.2% Na_2O. At one locality the altered tuff is composed nearly entirely of albite. A shard texture is preserved in both the analcime-rich and albite-rich rocks. Analcime is considered to have developed from a reaction of volcanic glass and sea water (possibly hypersaline) at some diagenetic stage and was converted in variable amount to albite at higher temperatures and pressures due to deep burial.--Auth.

2-3060. Pitts, Anna C., and others. SUPPLEMENT TO INDEX LIST OF WELL CUTTINGS FILED AT KENTUCKY GEOLOGICAL SURVEY: Kentucky Geol. Survey, Ser. 10, Inf. Circ. 3, 34 p., 1960.

This publication is a supplement to Kentucky Geological Survey, Ser. 9, Inf. Circ. 7, by H.B. Wood and A.J. Walker, 1956. It is an index of approximately 1,000 sets of well cuttings which have been received, processed, and filed at the Sample Library of the Kentucky Geological Survey in Lexington since the above index was published. Samples processed after Dec. 1, 1959, are not included on this list.

All sample sets listed herein are available for inspection at the Sample Library by any interested individual or company.--T.J. Crawford.

2-3061. McMaster, Robert L. SEDIMENTS OF NARRAGANSETT BAY SYSTEM AND RHODE ISLAND SOUND, RHODE ISLAND: Jour. Sed. Petrology, v. 30, no. 2, p. 249-274, 2 maps, 11 charts, 4 tables, June 1960, 34 refs.

Gravel, sand, silt, and clay content was determined for 942 samples from the bays and adjacent inner shelf to a distance of some 20 mi. off the Rhode Island coast.

In the Narragansett Bay system clayey silt and sand-silt-clay are the most abundant sediments although sand is important locally. Neither the Bay system nor the inner shelf contain a predominant clay type of sediment. Primarily, sediments are derived from the unconsolidated subaerial and subaqueous glacial and postglacial deposits. It is believed that the sediment available for deposition is composed of some fine and very fine sand, silt, and clay, but the quantity is very small. During the period in which present environmental conditions have been effective, clayey silt and sand-silt-clay have accumulated for the most part in the more protected middle and upper areas of the Bay system. The depositional sites for the finest of these sediments may be the result of the peculiarities of surface tidal current flow. Areas which show marked gradational changes in texture probably indicate significant local variations in current activity along the bottom interface. In general, toward the lower reaches of the Bay passages the sediments show a progressive change to coarser textures.

On the inner shelf the predominant sediment type is clean, well-sorted sand. Apparently gravel is concentrated along 2 major trends which are generally associated with the 2 submarine elevation features that cross the area. A well-defined depositional zone of sandy silt and silty sand, believed to be the result of nontidal drift, begins near the entrances to Narragansett Bay and follows the trend of a winding submarine slope toward the SW. and Block Island Sound. A tongue of sand which lies adjacent to the Rhode Island mainland from Point Judith into lower West Passage owes its origin to the northerly moving longshore current which pushes into the Bay from Block Island Sound.

In the Bay system and certain areas on the inner shelf, unburied glacial or postglacial lag deposits juxtapose with recently accumulated fine sediments.

Present environmental forces are not responsible for the creation of the major submarine topographic features of the region, but in the Bay depositional processes of recent environmental conditions have had considerable success in burying sedimentary deposits of previous environments.--Auth.

11. GEOHYDROLOGY

See also: Areal and Regional Geology 2-2809; Geomorphology 2-2825; Geochemistry 2-2996, 2-3006 through 2-3010; Sedimentary Petrology 2-3049.

2-3062. Rainwater, Frank H., and L. L. Thatcher. **METHODS FOR COLLECTION AND ANALYSIS OF WATER SAMPLES: U.S. Geol. Survey, Water-Supply Paper 1454, 301 p., 9 illus., 7 diags., 3 tables, 1960, refs.**

This manual contains methods used by the U.S. Geological Survey to collect, preserve, and analyze water samples. Throughout, the emphasis is on obtaining analytical results that accurately describe the chemical composition of the water in situ. Among the topics discussed are selection of sampling sites, frequency of sampling, field equipment, preservatives and fixatives, analytical techniques of water analysis, and instruments. Seventy-seven laboratory and field procedures are given for determining 53 water properties.--Auth.

2-3063. U.S. Geological Survey, Water Resources Division. **HYDRAULIC CONVERSION DATA:** Am. Geol. Inst., AGI Data Sheet 19, 2 p., in GeoTimes, v. 5, no. 2, p. 35-36, Sept. 1960.

Widely used systems of measurement in hydraulic studies are indicated, and the necessary factors to convert from one to another are given. They are grouped under volume, volume conversion factors, velocity, pressure, weight, rates of flow, and rate conversion factors.--M. Russell.

2-3064. Leopold, Luna B., Ralph A. Bagnold, M. Gordon Wolman, and Lucien M. Brush, Jr. **FLOW RESISTANCE IN SINUOUS OR IRREGULAR CHANNELS:** U.S. Geol. Survey, Prof. Paper 282-D, p. 111-134, 3 illus., map. 3 secs., 17 diags., 5 tables, 1960, 5 refs.

The resistance to fully developed turbulent flow at constant depth in an open channel increases as the square of the mean velocity as long as the boundary conditions remain completely unchanged. The presence of the free water surface allows the possibility of departure from the relationship of resistance to the square of the velocity. Experimental evidence is given, which is in quantitative agreement with fluid dynamic theory, that such departure may be abrupt, with a marked increase of resistance. These departures are observed under conditions of boundary and flow which occur commonly in natural rivers.

It is shown that the condition under which this discontinuous increase in resistance occurs is definable by the mean Froude number for the whole flow which may be as small as 0.4. At this initial state, the rate of resistance increase with the square of the velocity may be more than double.

The phenomenon, which is absent in straight uniform channels, is associated with excessive deformations of the free surface due to transverse deflections of the whole or a part of the flow by changes along the channel in the curvature of the flow boundary.

In the simple cases examined, the critical Froude number at which the sudden jump occurs depends mainly on the ratio of channel width to mean radius of channel curvature, though the inclination of the banks appears also to have a minor effect.

Over the range of values of the above ratio usually to be found in natural rivers, the critical Froude number ranges between 0.4 and 0.55. The possible significance is discussed of the remarkable correspondence between this range of critical Froude number and the range of Froude number within which river flow at bankfull stage appears to be restricted.--Auth.

2-3065. Meyboom, Peter. **GEOLOGY AND GROUNDWATER RESOURCES OF THE MILK RIVER SANDSTONE IN SOUTHERN ALBERTA:** Research Council Alberta, Geol. Div., Mem. no. 2, 86 p., 26 figs., 13 tables, 1960, 66 refs.

A great number of artesian wells in southern Alberta obtain their water from the Milk River sandstone, which is the largest sandstone aquifer in the province. This study was initiated because of a serious decline of water level in many of the wells. The area of investigation is located between townships 1 and 12, within ranges 1 to 19 inclusive, W. of the Fourth Meridian.

The major structural elements in this area are the NW.-trending Kevin Sunburst dome and the NE.-trending Bow Island arch, together called Sweet Grass arch. These structures were determined mainly by vertical movements of the basement complex, which are reflected by the overlying younger strata.

The Milk River sandstone is the lower member of the Upper Cretaceous Eagle formation and is stratigraphically equivalent to the Virgelle sandstone in NW. Montana. The Milk River sandstone consists of fine-grained sandstones and shales, interbedded in lenticular fashion and pinching out to the N. A study of the vertical variability of the sandstone beds revealed the presence of some NW.-trending belts of relatively clean sandstone, 200 ft. thick. The Milk River sandstone is believed to have originated on the seaward margin of a littoral environment.

The aquifer is characterized by relatively low transmissibilities, ranging from 2,000 in the S., to less than 10 near the sand pinchout in the N. A path of high transmissibility values coincides with one of the NW.-trending sand belts. The piezometric surface has an average gradient of 20 ft. per mi. in a northern direction, and owing to the low permeability the rate of ground-water movement does not exceed 20 ft. per year. There has been continuous depletion of the aquifer since development began, and approximately 50% of the amount of water produced is drawn from storage. The storage coefficient of the aquifer is 0.0003. The piezometric surface has been lowered an average of 20 ft. since 1937. In some areas of heavy withdrawal (Pakowki Lake, Foremost) this value is as high as 100 ft. Areas of lesser depletion act as ground-water divides. Natural replenishment to the aquifer occurs in the Sweet Grass Hills, where the Milk River sandstone is uplifted by several intrusions and is exposed. Infiltration along the outcrop area in the Milk River valley is not a substantial form of recharge. The water in the central part of the area has a moderate content of sodium bicarbonate (1,000 p.p.m.) and a moderate degree of mineralization (1,000 p.p.m. total dissolved solids). Toward the N., E., and W., connate water has not yet been replaced by infiltrating meteoric water. Natural gas, which is produced together with the water in some of the wells, is believed to occur in solution.

Water from the Milk River sandstone is used mainly for domestic purposes and livestock watering. At present there are 409 wells, producing a total of 700,000 gallons per day.

The total recoverable ground-water resources of the Milk River sandstone are calculated to be 9.3 x 10^9 cu. ft. At the present rate of withdrawal from storage and with very careful development, this reserve should last 200 years. Heavy withdrawal around Foremost, Bow Island, and Pakowki Lake is expected to create a water shortage much sooner. The present situation justifies an extensive conservation program.--Auth.

2-3066. Peterson, William C. WATER-RESOURCES SUMMARY FOR SOUTHERN CALIFORNIA, 1959: U.S. Geol. Survey, Circ. 429, 26 p., 8 figs., 1960.

Water supply and precipitation are discussed. Data are given for annual surface runoff in 1959 at 15 selected gaging stations. These data are compared to the average for a 35-year base period 1920-1955, for the dry period 1944-1959, and for runoff in 1958 at all stations in the area. The section on ground water describes conditions in individual valleys and contains hydrographs of 6 observation wells.--U.S. Geol. Survey.

2-3067. Newcomb, Lawrence E., and Joseph T. Callahan. WATER FOR ATLANTA: Georgia Mineral Newsletter, v. 13, no. 1, p. 1-9, 5 illus., map, diag., graph, Spring 1960, 5 refs.

A brief history of the development of the Atlanta, Georgia, water supply system, starting in 1893 with a single deep well to the present system comprising 1 treatment plant, 3 pumping stations, and 6 reservoirs. The present consumption is shown, and future needs, based on population and industrial growth, are estimated.

The present firm water supply now consists of 400 m.g.d. from the Chattahoochee River, 25 m.g.d. from small streams, and about 20 m.g.d. from wells. The water is of good quality.

Wastes from industrial plants and treated sewage wastes are discharged into the Chattahoochee River and some of its tributaries, downstream from intakes for municipal water supplies.--J.G. Lester.

2-3068. Wait, Robert L. SUMMARY OF THE GROUND-WATER RESOURCES OF CALHOUN COUNTY, GEORGIA: Georgia Mineral Newsletter, v. 13, no. 1, p. 26-31, map, 3 tables, Spring 1960, 6 refs.

Brief discussion of the stratigraphy of the area with indicated aquifers and estimated water production from each. Tables showing production records from 5 selected wells and rather complete chemical analyses of the waters are given. The principal aquifers are found in the Clayton, Tallahatta, Lisbon, and Ocala formations [Eocene].--J.G. Lester.

2-3069. Wait, Robert L. SUMMARY OF THE GEOLOGY AND GROUND-WATER RESOURCES OF CLAY COUNTY, GEORGIA: Georgia Mineral Newsletter, v. 13, no. 2, p. 93-101, 2 maps, sec., 2 diags., 2 tables, Summer 1960, 7 refs.

A study of the ground-water potential of Clay County assumes a certain importance in view of the new W.F. George Lock and Dam at Ft. Gaines and the expected industrial development of the area.

Ground-water is the least expensive and most available water to supply expected demands. Sediments of Pleistocene to Late Cretaceous are exposed and include Flint River, Ocala, Lisbon, Tallahatta, Wilcox, Clayton, Providence, Ripley, Cusseta, Blufftown, Eutaw, and Tuscaloosa formations.--J.G. Lester.

2-3070. Stewart, J.W., and M.S. Craft. GROUND-WATER WITHDRAWALS AND DECLINE OF ARTESIAN PRESSURES IN THE COASTAL COUNTIES OF GEORGIA: Georgia Mineral Newsletter, v. 13, no. 2, p. 84-93, 7 maps, 5 charts, 10 tables, Summer 1960, 11 refs.

Artesian pressures have fallen 10-90 ft. in the coastal counties of Georgia since 1943 owing to the increased use of ground water for domestic, municipal, and industrial supplies.

Large and well-defined cones occur in the piezometric surface in the Savannah, Brunswick, Jesup, and St. Marys-Fernandina areas. At Savannah, the piezometric surface is as much as 120 ft. below sea level; at Brunswick it is 10 ft. above sea level; at St. Marys it is 5-15 ft. above sea level; and Jesup is about at sea level.--J.G. Lester.

2-3071. Callahan, Joseph T. WILD-FLOWING WELLS WASTE WATER: Georgia Mineral Newsletter, v. 13, no. 1, p. 21-23, 2 illus., 2 tables, Spring 1960, ref.

Result of an inventory of water wells in the coastal counties of Georgia. Table 1 gives the number of flowing wells in the 10 Georgia coastal counties and the use made of the water. Of 377 wells in Jan. 1959, 98 were unused. Table 2 gives the estimated withdrawal of ground water (1957) in million gallons per day; 12% of the withdrawal is wasted.--J.F. Lester.

2-3072. Smith, Rex O. GEOHYDROLOGIC EVALUATION OF STREAMFLOW RECORDS IN THE BIG WOOD RIVER BASIN, IDAHO: U.S. Geol. Survey, Water-Supply Paper 1479, 68 p., 3 maps (2 in pocket), 17 secs., diag., 5 graphs, 2 tables, 1960, 10 refs.

The Big Wood River basin covers an area of about 3,300 sq. mi. in S.-central Idaho. A preliminary study was made both of the geologic and ground-water conditions in the vicinity of stream-gaging stations on the Big Wood River and its tributaries and of the effects of those conditions on streamflow. The accuracy or validity of streamflow records was not questioned, but information was sought on the relation of measured streamflow and water yield (total outflow through either surface channels or subsurface aquifers) of the basin above the gaging stations where the records were collected...

The formations exposed in the basin range in age from Precambrian to Recent and include a wide variety of rock types. These may be grouped broadly as pre-Tertiary sedimentary rocks, pre-Tertiary granitic rocks, Tertiary intrusive rocks, Tertiary volcanic rocks, basalt of Quaternary age, unconsolidated Quaternary sediments, and Quaternary windblown materials.

The pre-Tertiary sedimentary and granitic rocks and the Tertiary intrusive rocks are not important aquifers, although locally they yield small amounts of water. The Tertiary volcanic rocks yield small to moderate amounts of water to springs. Basalt of Quaternary age is the principal aquifer in the southern third of the basin. Unconsolidated Quaternary sediments, consisting of coarse sand and gravel with tongues and lenses of silt and clay, are the principal aquifers in the valleys and lowlands of the northern mountainous half of the basin.

The geohydrologic conditions at some gaging stations in the Big Wood River basin are relatively simple, requiring little explanation or interpretation. A station on Warm Springs Creek at Guyer Hot Springs near Ketchum and another on the West Fork of Fish Creek near Carey, for example, provide records that seem to represent accurately the water yield of the drainage area above the stations. At those stations subsurface movement of ground water through the alluvial valley fill is a negligible part of the water yield, and the relatively impermeable bedrock beneath the alluvium transmits little or no ground water.

The records from other stations do not represent the water yield of the basin. Notable examples are stations in the alluvium-filled upper valley of the Big Wood River and along the northern edge of the Snake River basalt, where an appreciable part of the water yield is ground-water underflow. Ungaged ground-water underflow through alluvium in the Big Wood River valley probably is a significantly large part of the water yield of the basin above the stations on the Big Wood River near Ketchum and at Hailey. Much of the water yield of the Silver Creek drainage area and possibly an appreciable part of the water yield of the Camas Creek drainage area enter the basalt of the Snake River Plain upstream from gaging stations and leave those subbasins as ungaged underflow. The amount of ungaged ground-water underflow that passes through alluvium and basalt in the Little Wood River valley and which eventually enters the basalt of the Snake River Plain is unknown, but it may be a large part of the water yield of the Little Wood River drainage area. Much of the water yield of the Fish Creek drainage area enters basalt and alluvium upstream from the Fish Creek gaging station and bypasses the station.

Elsewhere in the Big Wood River basin, especially in extensively irrigated areas on the Snake River plain, complex geologic and hydrologic factors such as ground-water underflow through permeable basalt, importation of Snake River water for irrigation, ground-water recharge derived from imported water, return of ground water at shallow depths to surface streams, and exchange of water between canals, limit the usability of station records in appraising water yield. An analysis of the ratio of ground-water to surface-water discharge, and the relation of each to the water yield in these areas is not possible from available data. Nevertheless, these stations retain their basic value of recording streamflow at the stations and seepage losses between stations. The large volume of ground water that moves beneath these stations includes recharge contributions from the Big Wood River basin and other basins to the E.

The water yield of specific basin segments could be computed if adequate ground-water data were available from strategically located gaging stations. A more detailed study of water resources in the Big Wood River basin seems to be warranted.--Auth.

2-3073. Walton, William C. GROUND-WATER RESOURCES OF CAMAS PRAIRIE, CAMAS AND ELMORE COUNTIES, IDAHO: U.S. Geol. Survey, [Repts., Open-File Ser.], 125 p., 2 maps incl. geol. map (in pocket), scale 1:63,360, 2 secs., 5 diags., 4 graphs, 8 tables, July 1960, 13 refs.

Camas Prairie is an eastward trending intermontane basin along the N. flank of the Snake River plain in southern Idaho. The basin is about 40 mi. long and averages about 8 mi. wide. It was formed as a structural depression in which a considerable thickness of alluvial and lake deposits have accumulated behind basalt flows which at times blocked the outlet to the E. Intrusive and extrusive rocks of Cretaceous to Quaternary age enclose the basin on the N., W., and E. The enclosing rocks yield small amounts of water to springs and wells from the weathered mantle and fractures.

The principal aquifers are sand and gravel in the alluvial fill, and basalt. Water in the shallow deposits is not confined and the water table generally is less than 10 ft. below the surface at most places. Ground water in the deeper deposits occurs chiefly in 2 horizons which comprise the upper and lower artesian aquifers. Throughout much of the prairie, the pressure is sufficient that water will flow from wells penetrating these aquifers.

Recharge to the basin is from direct precipitation and percolation of stream runoff from the bordering mountains. Ground water moves from the higher areas at the base of the encircling mountains toward the center of the basin and the eastern outlet. The artesian aquifers leak by upward percolation through the imperfectly confining beds and help maintain the shallow water table. Basalt which interfingers with the alluvial deposits is an important aquifer near the SE. margin of the prairie and at the E. end. Annual recharge to the artesian aquifers is estimated to be about 40,000 acre-ft. Discharge from the artesian aquifers is about equally divided between upward leakage to the shallow aquifers and underflow out of the prairie. Most of the underflow discharges into Camas Creek or Magic Reservoir E. of the prairie; little of the underflow reaches the Snake River plain.

Wells drilled for irrigation generally yield 500 to 1,200 gallons per minute (g.p.m.) from the artesian aquifers. Better construction and development methods would result in considerably better yields. Wells drilled in the basalt will yield 2,000 to 3,000 g.p.m. with moderate drawdowns.

Computations made using aquifer coefficients estimated on the basis of data collected during the investigation suggest that 12,000 acre-ft. of ground water might be withdrawn annually. However, the aquifers are limited in areal extent, and productivity of the alluvial aquifers is not great. Consequently heavy development would result in large drawdowns in wells, and interference between wells would be great. The postulated large withdrawals from wells on the prairie would be supplied in part by a reduction in underflow from the prairie and in part by a decrease in leakage from the artesian aquifers, which in turn would cause a decline in the shallow water table.--Auth.

2-3074. Harder, Alfred H. THE GEOLOGY AND GROUND-WATER RESOURCES OF CALCASIEU PARISH, LOUISIANA: U.S. Geol. Survey, Water-Supply Paper 1488, 102 p., 9 pls. (in pocket, incl. 8 maps, fence diag.), 29 figs. incl. diags., graphs, 9 tables, 1960, 23 refs.

Large quantities of fresh ground water are available in Calcasieu Parish. Fresh water is present in sand of Recent, Pleistocene, Pliocene, and Miocene ages, although locally only small supplies for rural or stock use can be obtained from the shallow sand lenses of Recent and Pleistocene ages. The principal fresh-water-bearing sands are the "200-ft.," "500-ft.," and "700-ft." sands of the Chicot aquifer of Pleistocene age, from which 105 million gallons is pumped daily. A yield of as much as 4,500 g.p.m. (gallons per minute) has been obtained from a single well. The sands are typical of the Chicot aquifer throughout southwestern Louisiana in that generally they grade from fine sand at the top to coarse sand and gravel at the base of the aquifer.

The coefficient of permeability of the principal sands in Calcasieu Parish ranges from 660 to about 2,000 g.p.d. (gallons per day) per sq. ft. and averages 1,200 g.p.d. per sq. ft. The permeability of the sands generally varies with textural changes.

The maximum depth of occurrence of fresh ground water in Calcasieu Parish ranges from about 700 ft. to 2,500 ft. below mean sea level; locally, however, where the sands overlie structures associated with oil fields, the maximum depth is less than 300 ft.

Pumping has caused water levels to decline, at varying rates, in all the sands. In the "200-ft." sand they are declining at a rate of about 2 ft. per year. In the industrial district of Calcasieu Parish, levels in the "500-ft." sand are declining at a rate of about 5 ft. per year, and in the "700-ft." sand at a rate of about 3.5 ft. per year. Salt-water contamination is accompanying the water-level decline in the "700-ft." sand in the central part of the parish.

Quality-of-water data indicate that water from wells screened in the Chicot aquifer generally is suitable for some uses without treatment but would require treatment to be satisfactory for other uses. The temperature of the water ranges from 70° to 79°F.

The lenticular sands of Pliocene and Miocene ages have not been used as a source of fresh ground water in Calcasieu Parish; however, N. of the Houston River these formations contain fresh water, and the water contained in these formations in other parts of southwestern Louisiana is known to be soft and suitable for most purposes.--Auth.

2-3075. Moulder, Edward A., M. F. Klug, Donald A. Morris, and Frank A. Swenson. GEOLOGY AND GROUND-WATER RESOURCES OF THE LOWER LITTLE BIGHORN RIVER VALLEY, BIG HORN COUNTY, MONTANA: U.S. Geol. Survey, Water-Supply Paper 1487, 223 p., 16 maps (13 in pocket), 15 diags., 20 graphs, 28 tables, 1960, 34 refs.

The lower Little Bighorn River valley, Montana, is in the unglaciated part of the Missouri Plateau section of the Great Plains physiographic province. The river and its principal tributaries rise in the Bighorn Mountains, and the confluence of this northward-flowing stream with the Bighorn River is near the E. edge of Hardin, Montana.

The normal annual precipitation ranges from about 12 in. in the northern part of the area to 15 in. in the southern part. The economy of the area is founded principally on farming, much of the low-lying land adjacent to the river being irrigated. The irrigated land is within the Crow Indian Reservation, although a part is privately owned.

The bedrock formations exposed in the area are of Cretaceous age and include the Parkman sandstone, Claggett shale, Eagle sandstone, Telegraph Creek shale, and Cody shale. The Cloverly formation, Tensleep sandstone, and Madison limestone, which underlie but are not exposed in the area, and the Parkman sandstone in the southern half of the area appear to be the principal bedrock aquifers. All except the Parkman lie at depths ranging from a few feet to several thousand feet, and all appear to be capable of yielding water in commercial quantities. Some of the other formations are capable of yielding enough water for domestic and stock needs.

The river alluvium of Recent age and the Pleistocene terrace deposits are the principal unconsolidated formations in the area with respect to water supply and drainage. Wells yielding as much as 100 g.p.m. may be developed in favorable areas.

Pumping tests reveal that the transmissibility of the coarser unconsolidated materials probably ranges from about 15,000 to 30,000 g.p.d. per ft. Two tests of the Parkman sandstone showed transmissibilities of 6,000 and 20,000 g.p.d. per ft. Although a test of the Cloverly formation showed a transmissibility of only 3,000 g.p.d. per ft., the high artesian pressure - 80 lbs. per sq. in. at the land surface - in the Cloverly caused the tested well to yield about 200 g.p.m. by natural flow; this is greater than the yield of any other single well in the area.

Textural properties were compared with the hydraulic properties determined by laboratory tests to show the relation between different types of water-bearing materials. Materials classified as heavy soils - normally somewhat dense and impervious - had an average permeability of 7.2 g.p.d. per sq. ft., which was more than expected. One sample of very coarse alluvial material had a permeability of 6,000 g.p.d. per sq. ft.

The depth to water beneath irrigation units was mapped, thus showing the waterlogged areas. Waterlogging is not a serious problem where the water table is more than 6 ft. below the land surface.

For the drainage studies the unconsolidated deposits are classified in 2 zones - coarse-grained sediments resting on the relatively impermeable bedrock floor and overlying fine-grained sediments which extend to the land surface. The transmissibility of the coarse-sediment zone generally is many times greater than that of the fine-sediment zone.

Because in many places drains could not be economically dug deep enough to enter the coarse zone, the study of the effectiveness of drains completed in the fine zone received much attention. The studies showed that, despite a considerable thickness of fine-grained sediments between the bottom of the drain and the top of the coarse zone, drainage ditches frequently were effective in relieving waterlogging of fields nearby. Pilot relief wells installed in existing drains showed that the effectiveness of some drains could be increased appreciably by installing a series of relief wells.

Records of fluctuations of water levels in 196 observation wells and water-level contour maps were studied to show the principal areas of recharge and discharge in the irrigable areas. These studies show, for example, that canal leakage and underflow from small tributaries caused waterlogging by concentrating recharge in some localized areas. Tests made on one section of canal indicate that the canals leak at a rate of 100 to 400 g.p.d. per ft. of their length.

Specific proposals for draining waterlogged areas were made by considering all pertinent factors. The suggested depths and locations of the drains were based on a) the type and thickness of material to be drained, b) the source and amount of recharge to the area, c) the transmitting properties of both the coarse- and fine-sediment zones, d) the possible effects from proposed irrigation units, and e) the topography. Consideration of the drainage of sur-plus irrigation water and runoff is beyond the scope of this report.

Surface water from the Little Bighorn River and Lodge Grass Creek is the principal source of water for irrigation in the area.

Chemical analyses were made of 71 samples of water collected from several sources. Water from the Cloverly formation and the Parkman sandstone is soft and has a high Na content. Although in the southern part of the area the water from these bedrock aquifers is suitable for domestic and many industrial uses, its high percent Na makes it undesirable for irrigation. In general, the ground water from unconsolidated aquifers and the surface water are hard; the predominant ions in the ground water are Na and sulfate and in the surface water are Ca, Mg, and bicarbonate. The surface water from the perennial streams is best for irrigation, whereas ground water from the unconsolidated deposits is highly variable in mineral content and its suitability varies correspondingly. Ground water from the unconsolidated deposits generally is suitable for either irrigation or domestic use, but in a few locations the content of dissolved solids exceeds 4,000 p.p.m. and the water is undesirable for most purposes.--Auth.

2-3076. Johnson, C.R. GEOLOGY AND GROUND WATER IN THE PLATTE-REPUBLICAN RIVERS WATERSHED AND THE LITTLE BLUE RIVER BASIN ABOVE ANGUS, NEBRASKA: U.S. Geol. Survey, Water-Supply Paper 1489, 142 p., 8 maps (4 in pocket), 3 diags., 7 graphs, 1960, 17 refs.

This report describes an area of about 7,300 sq. mi. in S.-central Nebraska. Approximately one-fourth of the area, largely at its E. end, consists of an undissected southeastward-sloping upland plain and is almost wholly irrigable; the remainder is in various stages of dissection, and only parts of it are suitable for irrigation. Although some of the deeper lying bedrock formations are potential sources of water supply, they are not likely to be tapped in the near future because abundant supplies are available at shallower depth from semiconsolidated and unconsolidated deposits.

The Ogallala formation of Tertiary (Pliocene) age consists of gravel, sand, silt, and volcanic ash, some layers of which are partly cemented. It was deposited by eastward-flowing streams which formed a constructional plain above a surface into which the streams had previously eroded broad valleys. In turn, valleys were cut into the surface of the Ogallala before the overlying deposits of gravel, sand, silt, and clay of Quaternary (Pleistocene) age were laid down, also forming a constructional plain. During Recent time, streams have dissected the older deposits and have deposited thin alluvium in their valleys; also, several parts of the area have become mantled by wind-deposited sand. Because during Tertiary and Quaternary time the area repeatedly was the site of deposition and erosion, the thickness of all the stratigraphic units differs markedly from place to place. In general, however, the Ogallala formation thins eastward and in the central and eastern parts of the area is overlain by the eastward-thickening deposits of Pleistocene age. The maximum thickness of the Ogallala formation is about 500 ft., and the maximum thickness of the Pleistocene deposits is a little more than 300 ft. Each thins to a featheredge and is completely absent in parts of the area.

The water-bearing part of the combined Tertiary and Pleistocene deposits is considered to be a single zone of saturation because the ground water, as it percolates southeastward beneath the area, moves out of the Tertiary and into the Quaternary deposits without apparent hindrance. The water that enters the area as underflow from the W. is augmented within the area by water that infiltrates from the land surface. The principal sources of infiltrating water are precipitation, seepage from canals and reservoirs, and applied irrigation water. Except for the water withdrawn through wells or discharged by natural processes where valleys have been cut into the zone of saturation, ground water leaves the area as underflow into the Platte River valley on the N., the Blue River drainage basin on the E., or the Republican River valley on the S.

Part of the water used for irrigation and watering livestock and all the water used in rural and urban homes, in public buildings, and for industrial purposes is obtained from wells. To date (1952) there is no indication that the supply of ground water is being depleted faster than it is being replenished; instead, studies indicate that greater quantities can be withdrawn without causing an excessive decline of the water table. An increase of ground-water withdrawals to a sustainable maximum, however, will be possible only if the points of withdrawal are scattered fairly uniformly. It is estimated that annual withdrawals per township should not exceed 2,100 acre-ft. where infiltrating precipitation is the only source of recharge, or 3,000 acre-ft. where other sources of recharge are significant. Although perennial withdrawals of this amount could be sustained indefinitely, they would cause some lowering of the water table and eventually a decrease in the amount of water discharged from the area by natural means.

The ground water is of the calcium bicarbonate type. In much of the area it is hard or very hard, and in places it contains excessive amounts of Fe. In all other respects the water is chemically suitable for domestic use and is also suitable for irrigation. --Auth.

2-3077. Kimrey, Joel O. GROUND-WATER SUPPLY OF CAPE HATTERAS NATIONAL SEASHORE RECREATIONAL AREA. PART 2: North Carolina, Div. Ground Water, Rept. Inv. no. 2, 28 p., 4 maps (2 in pocket), sec., diag., 2 tables, 1960, ref.

In 1957, the U.S. National Park Service requested the aid of the U.S. Geological Survey to determine if an adequate ground-water supply could be obtained at previously selected sites within this recreational area. Pt. 1 of this report, by P.M. Brown, was prepared in 1958. The current report presents an evaluation of available ground-water supplies at additional sites for which information was requested in 1957. These sites are: Fort Raleigh National Historical Site, Oregon Inlet Campground, Pea Island Campground, Chicamacomico Station, Little Kinnakeet Station, the Cape Point area, the Hatteras Inlet proposed campground site, the Ocracoke Island proposed campground site, and the Ocracoke Docks Campground. The investigation, carried out during early 1959, consisted of a test-drilling program to determine depth to salt water and the areal extent, physical characteristics, and water-bearing properties of the unconsolidated sediments underlying the test sites. Results are presented.--From introd.

2-3078. Garza, Sergio, and John B. Wesselman. GEOLOGY AND GROUND-WATER RESOURCES OF

WINKLER COUNTY, TEXAS: Texas, Board of Water Engineers, Bull. 5916, 200 p., 8 maps (5 fold.), 5 secs. (3 fold.), 6 diags., 7 graphs, 9 tables, 1959, 32 refs.

Winkler County is in W. Texas adjacent to the SE. corner of New Mexico. Most of the county lies in the Pecos River valley; the remainder, the NE. portion, is part of the High Plains. Its principal industries are those related to the production and refining of oil, but ranching is also of importance. The county has an arid to semiarid climate, an area of about 887 sq. mi., and a population of about 12,000 in 1957.

The principal fresh-water-bearing formations in Winkler County are the Cenozoic alluvium, which mantles the surface of most of the county, and the Santa Rosa sandstone of Late Triassic age. The alluvium is saturated at a depth ranging from a few feet below the land surface to about 150 ft., and the ground water is unconfined. The Santa Rosa sandstone is fully saturated throughout most of the county, the water occurring under both unconfined and confined conditions. The underlying older formations contain water too highly mineralized for most uses, but they are important because water from these underlying beds, which is produced with oil, is a source of pollution to the fresh-water aquifers. The formations also are a source of water to waterflooding projects for the secondary recovery of oil.

The alluvium is replenished chiefly by precipitation throughout the county. The sand dune area in the eastern part is the most favorable area of natural recharge. The Santa Rosa sandstone is recharged through the alluvium where the 2 formations are in contact.

Infiltration of saline water that has been produced with oil and waste water from industrial plants has been taking place through surface earthen pits. About 18 m.g.d. (million gallons per day) of saline water was being produced from the many oil fields throughout the county during Aug. 1957, and almost all this water was placed in surface pits. The Hendrick oil field alone was producing about 14.5 m.g.d. during that month; an estimated 800,000 acre-ft. was produced from this field from 1937 to 1957.

Approximately 20 million acre-ft. of fresh water is stored in the explored ground-water aquifers of Winkler County, of which an estimated 5 to 7 million acre-ft. can be practicably recovered. A daily average of about 8.2 million gallons (9,200 acre-ft. per year) of fresh water was used in the county during 1956. Public and industrial use accounted for about 6.8 m.g.d.; irrigation, domestic, and stock uses accounted for 1.4 m.g.d. Projects engaged in the secondary recovery of oil were the largest consumers, using an average of about 3 m.g.d. of fresh water and about 2.7 m.g.d. of saline water during 1956.

Water wells drilled in the deep trough of Cenozoic alluvium S. of Wink may yield 1,000 g.p.m. (gallons per minute) or more. A pumping test of the alluvium in that area indicated a coefficient of transmissibility of about 25,000 g.p.d. (gallons per day) per ft. Wells, other than windmill wells, drawing water from thinner sections of alluvium in the rest of the county yield between 100 and 300 g.p.m. Most of the wells in the Santa Rosa sandstone yield between 30 to 400 g.p.m. Two municipal wells at Kermit tapping the Santa Rosa sandstone had test yields of 1,200 and 1,875 g.p.m. The large yield of these wells probably results from the presence of fractures in the structurally deformed aquifer. Pumping tests in the Kermit area indicate that locally a full section of the Santa Rosa sandstone has an average coefficient of transmissibility of about 25,000 g.p.d. per ft. and a coefficient of storage of about 0.0003. The transmissibility in 2 other tested areas is much less.

The chemical quality of the water in the principal aquifers is generally acceptable for industry and for public supply. About 2/3 of the samples collected from fresh-water wells had a dissolved-solids content of less than 1,000 p.p.m. (parts per million); however, some samples in a few areas were hard and high in fluoride and silica. Samples from wells in polluted areas contained dissolved solids ranging from about 1,400 to 71,100 p.p.m. Two comprehensive analyses of water samples from the Rustler formation [Permian] showed a dissolved-solids content of 18,400 p.p.m. and 157,000 p.p.m. In most of the water produced with the oil in the Hendrick oil field, the content of dissolved solids ranged from about 4,000 to about 10,000 p.p.m. The water produced with the oil in the rest of the oil fields in Winkler County was mainly brine.--Auth.

2-3079. Turner, Samuel F., Thomas W. Robinson, and Walter N. White. GEOLOGY AND GROUND-WATER RESOURCES OF THE WINTER GARDEN DISTRICT, TEXAS, 1948: U.S. Geol. Survey, Water-Supply Paper 1481, 247 p., 5 illus., 10 maps (4 in pocket), 6 diags., 5 graphs, 12 tables, 1960, 49 refs.

The Winter Garden district, as described in this report, includes all of Dimmit and Zavala counties and the eastern part of Maverick County - a total of about 3,200 sq. mi. The fieldwork for the investigation was completed in 1948.

The district, famed for its production of garden vegetables, is in the W. Gulf Coastal Plain and is drained chiefly by the Nueces River and its tributaries. The maximum relief is about 550 ft., and average annual rainfall is about 20 in.

The rocks exposed in the Winter Garden district are mostly sedimentary and from oldest to youngest are as follows: the San Miguel, Olmos, and Escondido formations of Cretaceous age; the Kincaid and Indio formations, the Carrizo sand, and the Mount Selman and Cook Mountain formations of Tertiary age; the Uvalde gravel of Tertiary(?) age; and the Leona formation of Quaternary age. None of the rocks in the district older than the Indio formation contain fresh water, and the Uvalde gravel is devoid of water.

The Indio formation is composed predominantly of thin-bedded and laminated clayey sand and sandy shale. It also includes some thick layers of clay, both lenses and persistent layers of sandstone, a few beds of lignite, and numerous calcareous, arenaceous, and ferruginous concretions.

The Carrizo sand consists of beds of massive, commonly crossbedded, loosely cemented, remarkably clean sand. It is composed chiefly of grains of pure quartz that range from a fraction of a millimeter to slightly more than 5 mm. in diameter.

The Bigford member of the Mount Selman formation consists chiefly of clay but also contains subordinate amounts of sandy clay, sandstone, beds of lignite, beds of yellow limestone, and some thin beds of hematite.

The post-Bigford beds of the Mount Selman formation are similar lithologically to the Bigford member but are composed principally of clay and a few relatively thin layers of sandstone and limestone.

The Cook Mountain formation consists chiefly of partly consolidated medium-grained sand and sandstone.

The formations dip about 60 ft. per mi. to the S. and SE., a slope that is somewhat greater than that of the land surface; thus, progressively younger beds are exposed from NW. to SE. The Uvalde gravel and Leona formation are distributed unevenly over the beveled edges of the older rocks. The structure is modified by a broad syncline trending slightly S. of E. through the center of Zavala County and a broad anticline passing southeastward through Carrizo Springs. Several minor faults were mapped, but the faults probably have little effect on the occurrence and movement of ground water.

The principal water-bearing formations in the district are the Carrizo sand and the Leona formation. Minor water-bearing formations include the Indio formation and the Bigford member of the Mount Selman formation. The Carrizo sand and the Leona formation both yield water suitable in quantity and quality for irrigation. The Leona is the less important of the 2 owing to its limited thickness and areal extent.

The Carrizo sand crops out in a crescent-shaped band that roughly parallels the western, northwestern, and northern edges of the district. Wells tapping the Carrizo sand provided about 27,000 acre-ft. of water to irrigate about 27,000 acres in the district in the irrigation season of 1929-1930. about 22,000 acre-ft. of water to irrigate about 24,000 acres in the irrigation season of 1937-1938, and about 52,000 acre-ft. of water to irrigate about 42,000 acres in the irrigation season of 1947-1948. The withdrawals caused declines of artesian pressure in the artesian area of the Carrizo sand ranging from 0.2 ft. to 42.4 ft. between 1947 and 1948, and water levels in some wells declined about 90 ft. between 1930 and 1948.

Laboratory tests of samples and pumping tests indicate that the Carrizo sand has an average permeability of about 200 g.p.d. per sq.ft. and an average transmissibility of about 30,000-40,000 g.p.d. per ft. The tests showed a storage coefficient of about 0.0001 in the artesian area; it is conservatively estimated to be about 0.1 in the outcrop area.

The Leona formation crops out in narrow strips adjacent to the Nueces and Leona rivers. About 6,800 acre-ft. of water was pumped from the Leona formation in Zavala County to irrigate about 5,100 acres in 1947-1948. The withdrawal resulted in the temporary failure of several irrigation wells in the Batesville area.

Records and locations of more than 1,100 wells, water-level measurements made in representative observation wells from 1929 through 1948, and hydrographs from 6 representative wells are illustrated and tabulated in the report.

The quality of water varies between wide limits in all formations. Generally, water from the Leona formation is the best for irrigation and the least mineralized. Water in the Carrizo becomes softer downdip as the percent Na increases. Water from the Bigford member of the Mount Selman formation and the Indio formation in parts of the district is too highly mineralized for most uses. The investigation revealed that the contamination of wells in the Carrizo sand by mineralized water from the Bigford member of the Mount Selman formation is a local problem and that up to 1948 no general contamination had occurred in the Carrizo sand.--Auth.

12. MINERAL DEPOSITS

See also; Geologic Maps 2-2799; Areal and Regional Geology 2-2806; Geophysics 2-2951, 2-2990, 2-2992; Geochemistry 2-3000, 2-3011, 2-3015.

2-3080. U.S. Bureau of Mines. MINERAL FACTS AND PROBLEMS, 1960 EDITION: Its: Bull. 585, 1015 p., diags., graphs, tables, 1960, refs.

A new edition of a reference volume which first appeared in 1956 as U.S. Bureau of Mines, Bull. 556, on metals, nonmetals, mineral fuels, and the industries that produce them. Facts have been brought up to date, and outlook and problems concerning minerals have been reappraised. The volume consists of 87 chapters, each devoted to an outstanding mineral or metal from A to Z - aluminum to zirconium, plus an introduction and an index. The history, sources, technology, and uses - past, present, and probable - of each mineral are discussed.

2-3081. Slichter, Louis B. THE NEED FOR A NEW PHILOSOPHY OF PROSPECTING: Mining Engineering, v. 12, no. 6, p. 570-576, 9 diags., table, June 1960, 7 refs.

Looking to the future, it is a good guess that the costs of finding ore will increase in response to increasing technical difficulties. To continue to achieve profits from prospecting, it will become necessary to analyze the business more skillfully, in a more and more sophisticated manner. Without belittling in the least the importance of improving all the tools for finding ore - geological, geophysical, and geochemical - the author urges the primary importance of appraising the expectations of finding ore. The vital statistics in prospecting are just as vital to prospectors as are the corresponding vital statistics in the insurance business. Actuarial experts of a new type are needed to compile the needed information and to appraise the risks in prospecting blind. We need to improve the art of comparing prospecting ventures in terms of the odds, in a word in terms of numbers.--Auth.

2-3082. Kleinkopf, M. Dean. SPECTROGRAPHIC DETERMINATION OF TRACE ELEMENTS IN LAKE WATERS OF NORTHERN MAINE: Geol. Soc. America, Bull., v. 71, no. 8, p. 1231-1241, 4 maps, 6 tables, Aug. 1960, 18 refs.

Spectrographic determination of trace elements in lake waters is utilized as a reconnaissance prospecting method for a remote area containing about 20,000 sq. mi. in northern Maine. This paper shows how the method was developed and presents the trace-element-distribution pattern as defined from the elemental concentrations found in lake waters.

Data for 12 elements normally present in trace amounts in natural waters - Mn, Pb, Ag, Zn, Cu, Ni, Zr, V, Mo, Cr, Sn, and Ti - were evaluated by comparing the traces present from lake to lake. Determinations in weight percent of element concentrations in evaporated-water residue furnished data which are believed to be essentially unaffected by rates of erosion and changes in amounts of rainfall and runoff. Values for each element, when plotted on a base map of Maine, suggest that lakes that have higher values may form groupings which represent localities that have greater possibilities for mineralization. These groupings constitute the spectrographic anomalies.

The significance of these anomalies has been established in several ways. Spectrographic values obtained for each element are believed to represent an integrated value of the surrounding terrain. Anomalies correlate with geologic features in several cases, and some are confirmed by known mineralization.--Auth.

2-3083. Hawkes, Herbert E. **STATUS OF GEOCHEMICAL PROSPECTING IN THE USSR: Mining Engineering, v. 12, no. 6, p. 591-593, 4 tables, June 1960, 5 refs.**

The significance of geochemistry to Russian plans of greater mineral productivity is assuming major proportions. The author provides a resume of their organization and progress in this field. The following conclusions are drawn: geochemical prospecting in Russia and the West has evolved independently, many of the developments paralleling each other. In some cases Western methods are more advanced, in others the reverse is true. Principal difference is in scale of operations. In 1956, date of the most recent full report on geochemical prospecting activity in the Soviet Union, the Russian work in both experimental and applied fields of geochemical prospecting was probably between 5 and 10 times the efforts of all Western nations combined.--Auth.

2-3084. Amstutz, G.C. **SYNGENETIC ZONING IN ORE DEPOSITS: Geol. Assoc. Canada, Proc., v. 11, p. 95-113, 8 figs. incl. 2 illus., diags., secs., table, Dec. 1959, 16 refs.**

Zoning in rocks and mineral deposits may originate from epigenetic as well as from syngenetic processes. A distinction between these 2 modes of origin is essential to a sound philosophy of exploration.

Criteria for and against syngenetic and epigenetic zoning are discussed on the basis of typical examples. Although there are occasionally transitions, it is possible to show some marked differences between textural and compositional (geometrical and geochemical) gradients of syngenetic as compared with epigenetic zones in rocks and mineral deposits.

A step-by-step analysis of detailed features of zoning in sediments, lavas, and intrusions is performed, by keeping 1 or 2 of the 3 principal genetic parameters constant (time, space or shape, and physicochemical conditions or composition). This is achieved, for example, by comparing geochemically identical features of different size or shape. In layered deposits such top-bottom or sequence features as described by Shrock are of considerable genetic value.

These comparisons of isochemical and/or isogeometric and/or synchronous features in rocks and mineral deposits lead to the preliminary conclusions that the criteria for syngenetic zoning in the following deposits are more abundant and need fewer assumptions than the epigenetic hypotheses: 1) the Michigan Cu deposits in the lavas and sediments; 2) the Mississippi Valley-type deposits; 3) the Colorado (Plateau) U and the red bed Cu deposits; 4) the Witwatersrand-Blind River type deposits.

A by-product of this study was the observation of a human factor which shows up as a discontinuity of interpretation at the size level of a mineral deposit at which it becomes of economic interest. Many publications offer an in situ interpretation for noncommercial deposits which are geochemically and geometrically identical with deposits of economic value, but which were given a migrationistic, epigenetic origin.--Auth.

2-3085. Silverman, A.J., A. Long, and J. Lauren Kulp. **AGE OF COEUR D'ALENE MINERALIZATIO AN ISOTOPIC STUDY: Mining Engineering, v. 12, no. 5, p. 470-471, May 1960, 13 refs.**

Discussion of "The Gem Stocks and Adjacent Ore bodies, Coeur D'Alene District, Idaho" by Garth M. Crosby (GeoScience Abstracts 1-2384).

Isotopic study of Pb samples from 10 mines N. an S. of the Osburn fault, Coeur D'Alene district, Idah indicates that classical interpretation of existing geo logic descriptions of the deposits surrounding the Gem stocks might lead to false conclusions on the mechanism and history of mineralization. Nine of the 10 Pb age determinations give 1,300-1,400 millio years. One, from Sunset Prospect Mine, is of Tertiary age. Structural relations as they bear on history of mineralization are discussed.--M. Russell.

2-3086. Thomson, D.R.S. **SULFIDE OREBODIES AT YAURICOCHA, PERU: Econ Geology, v. 55, no 5, p. 1070, Aug. 1960.**

Discussion of a paper by H. Ward (GeoScience Abstracts 2-441). While Ward puts forward an interesting idea to explain the textures shown by the pyrite, he fails to substantiate it. The distribution of the breccias and their relationship to the regional joints and fractures preclude their being reef breccias. The writer hopes to publish a different hypoth esis showing that the emplacement of the ore bodies was accompanied by mineralization stoping.--J. A. Chamberlain.

2-3087. Timms, P.D., and D. Marshall. **THE GEOLOGY OF THE WILLROY MINES BASE METAL DEPOSITS: Geol. Assoc. Canada, Proc., v. 11, p. 55-65, 2 maps, 5 secs., Dec. 1959.**

The Willroy Mines base metal deposits [N. shore, Lake Superior, Ontario] consist of Cu-Zn sulfide bodies of the replacement type. They occur within a 2 to 3 mi. wide band of Keewatin metavolcanics and sediments. The band is hook-shaped and is sur rounded by Archean granite gneiss and migmatite.

All the ore bodies occur within the metasediments along E.-W. strike-shear zones, parallel to the granite contact, and replace either Fe formation or sericite schist. Generally all the lens-shaped ore bodies exhibit similar attitudes in strike and dip and plunge eastward at shallow angles in the same direction as the lineations of the mafic minerals of the host and country rocks. Although much alike in other respects, the different bodies vary widely in their content of chalcopyrite, sphalerite, and galena.

The principal metals are Zn and/or Cu with variable subordinate amounts of Pb, Ag, and Au.--Auth.

2-3088. Latulippe, Maurice. **THE MATTAGAMI AREA OF NORTHWESTERN QUEBEC: Geol. Assoc Canada, Proc., v. 11, p. 45-54, map, Dec. 1959, 22 refs.**

The Mattagami area of northwestern Quebec is underlain with Keewatin-type volcanic and sedimentary rocks and Temiskaming-type sedimentary rocks intruded by basic and ultrabasic sills. These have been isoclinally folded. During and after this folding granitic and dioritic dikes, sills, and batholiths were emplaced. The sulfides of pyrite and pyrrhotite occur in numerous places but favor the sedimentary horizons and appear as linear zones. Only in a few places within these linear zones have concentrations of Cu-Zn bearing sulfides been located. The 4 prinipal base metal discoveries made to-date are Mat- agami Lake Mines, Orchan Mines, New Hosco lines, and Garon Lake Mines.--Auth.

-3089. Byers, A. Roddick. BASE METAL MIN- RALIZATION ASSOCIATED WITH PEGMATITE, ORTHERN SASKATCHEWAN: Geol. Assoc. Canada, roc., v. 11, p. 81-88, map, sec., plan, Dec. 1959, 1 refs.

Chalcopyrite and sphalerite occur intimately as- ociated with lenses and sills of high-temperature, eplacement-type pegmatite in biotite garnet and/or ornblende garnet gneisses of the amphibolite-granu- ite facies. Two deposits so far tested, one near Ianson Lake and the other at Brabant Lake, have nteresting economic possibilities.

The pegmatites consist essentially of oligoclase, nicrocline, and quartz. The zinc spinel gahnite is rare but characteristic accessory mineral. Pri- nary sulfide minerals also include pyrrhotite, pyrite, nd galena. Covellite of supergene origin increases he content of Cu at and immediately below the pres- nt surface, whereas sphalerite has been leached nd some Zn removed.

The temperature of formation, as indicated by the omposition of the sphalerite, is at least 550°C.

This type of deposit is considered to represent he end phase of a period of granitization, metaso- natism, and pegmatization.--Auth.

-3090. Kendall, David L. ORE DEPOSITS AND EDIMENTARY FEATURES, JEFFERSON CITY INE, TENNESSEE: Econ. Geology, v. 55, no. 5, . 985-1003, 7 illus., 2 maps, sec., Aug. 1960, 5 refs.

The Mascot-Jefferson City Zn district, extending rom about 15 to 30 mi. NE. of Knoxville, lies in entral E. Tennessee, in the Appalachian Valley and idge province. The ore bodies, restricted to about 50 ft. of dolomitized limestone in the Lower Ordo- rician Kingsport and Longview formations are elon- ated and continuous with bedding but are irregular n detail. Distinction is made between coarse- rained and fine-grained dolomites. Both types are elieved to have been formed penecontemporaneous ith deposition. Ore has been deposited as replace- nents and open-space fillings in coarse dolomite, ut only as fracture filling in fine dolomite.

Sedimentary breccias of 2 principal types are istinguished: coarse-grained dolomite breccia ocated in dolomitized limestone beds and restricted o these beds; and, fine-grained dolomite breccias rosscutting the stratigraphic section. Reefs of oarse dolomite, possibly of algal origin, surrounded y limestone characteristically are capped with phalerite and are good ore guides, grading into arge shoots of replacement-type ore.

Vug-filling laminated clastic dolomite with lam- nations parallel to country rock bedding is post-ore nd indicates ore deposition while beds were flat. his, together with the marked stratigraphic restric- ion of the ore and its intimate association with sedi- nentary structures, permits an alternative to the ustomarily cited tectonic structure-hydrothermal heory of origin. Concentration and deposition from he sea contemporaneous with sedimentation is sug- ested. Later regeneration of such a deposit would xplain the migration of mineralization into fractured ine-grained dolomite.--Auth.

-3091. Howell, Fred H., and John S. Molloy. EOLOGY OF THE BRADEN OREBODY, CHILE, SOUTH AMERICA: Econ. Geology, v. 55, no. 5, p. 863-905, 2 illus., 5 maps, 2 charts, 4 secs., Aug. 1960, 14 refs.

The El Teniente Mine of the Braden Copper Company, 45 mi. SE. of Santiago in central Chile, is the largest underground Cu mine in the world. Although the immense Braden ore body has been exploited on a large scale since about 1908, the only published description of the deposit stems from a brief examination by Lindgren and Bastin in 1917. Since that time, extensive exploratory and development work have provided a wealth of new evidence. This paper presents a description of the deposit and conclusions regarding its origin based upon a recent 3-year study of the ore body and its environs.

Bedrock near the mine consists mostly of extensive volcanic flows and intercalated terrestrial sediments containing numerous unconformities and disconformities. These rocks are correlated with the Tertiary(?) Farellones formation, a recently-established stratigraphic unit that includes the uppermost portion of an extremely thick (50,000+ ft.) series of rocks deposited in the Andean geosyncline during Mesozoic and early Tertiary time. These rocks, predominantly andesites, have been broken by strong NE.-striking faults and intruded by quartz diorite, dacite porphyry, and hornblende lamprophyre.

The most prominent structural feature in the mine area is the Braden Pipe - a circular, downward-tapering hole in the volcanics, filled with a breccia, and surrounded by the ore body. It is believed that the Braden Pipe developed after ore deposition and upon the site of an older stock of dacite porphyry. There seems to have been intermittent vertical displacement of the fragmental pipe-filling material, herein termed Braden formation, relative to the surrounding rocks. This displacement was probably both upward and downward, but the final movement was a substantial subsidence of material within the pipe.

Hydrothermal rock alteration appears to be comparatively mild, but indirect evidence suggests that the most intensely altered rocks may have been destroyed in the evolution of the Braden Pipe. The most obvious remaining alteration is the development of plentiful fine-grained secondary biotite throughout the andesite within the ore body.

Metallization was probably more or less continuous, but at least 5 distinct stages can be recognized. The first was a relatively unimportant deposition of quartz and a little pyrite in the NE.-striking faults. The second stage includes the main deposition of chalcopyrite and bornite with a quartz-anhydrite gangue. The third and fourth stages are characterized by abundant tourmaline with minor sulfides. The fifth and final stage deposited relatively unimportant amounts of tennantite, galena, and sphalerite in a quartz-carbonate gangue. Subsequent supergene enrichment has increased the original grade of primary ore almost twofold.

In comparing Braden with other mining districts, the Braden ore body, in spite of some apparent anomalies and structural peculiarities, seems to be almost a model porphyry-type deposit. The interrelationships of intrusive activity, breccia pipe formation, hydrothermal rock alteration, stockwork fracturing, and metallization are especially well illustrated and suggest certain generalities that might be applicable to all porphyry-type deposits.--Auth.

2-3092. Nagell, Raymond H. ORE CONTROLS IN THE MOROCOCHA DISTRICT, PERU: Econ. Geology, v. 55, no. 5, p. 962-984, 5 maps, chart, 2 secs., 2 tables, Aug. 1960, 10 refs.

The Morococha mining district, 70 mi. E. of Lima, Peru, is a source of Cu-Ag-Pb-Zn ores. Prospecting guides to ore are derived from an understanding of the complex structural history of the district during the Andean orogeny and the control exerted by geologic structure of the localization of ore bodies.

The stratigraphic section consists of the Permian Catalina volcanics and the Jurassic Potosi formation of limestone. Beginning in the Cretaceous and extending into the Tertiary, these rocks were folded, broken by thrust faults, brecciated, intruded by dioritic and quartz monzonite stocks, and cut by oblique fractures. Metasomatic alteration accompanied igneous intrusion and ore deposition.

Ore deposits in the forms of veins, contact pipes, and mantos are localized by the interacting effects of structural development which pre-dates, and, to a small extent, post-dates, hydrothermal ore deposition. Ore shoots in veins are controlled by dilation of the vein walls, proximity to contacts of contrasting rock types, mineralogical zoning about centers of ore mineralization, and depth below the surface. Intrusive contacts, limestone alteration contacts, and intersecting fractures are the dominant controls on the localization of the contact pipe and manto ore bodies.--Auth.

2-3093. Clarke, A.M., and P. Potapoff. **GEOLOGY OF McKIM MINE:** Geol. Assoc. Canada, Proc., v. 11, p. 67-80, 4 illus., 3 maps, sec., diag., Dec. 1959.

The McKim mine ore body, a relatively medium-sized Ni-Cu sulfide deposit in the Sudbury [Ontario] camp, is situated on the S. contact of the southern limb of the Ni irruptive about 2 mi. W. of the famous Frood Mine. The ore occurs as a mineralized breccia zone lying between hanging wall norite and footwall greenstone and granite. The ore zone strikes northeasterly, dips 50° NW., and attains widths up to 125 ft. Minor amounts of "main" ore type sulfides and pentlandite-rich type sulfides exist in the footwall. The important structural controls for the ore shoots are the proximity of the norite and "rolls" in its contact with the footwall rocks where a swell of ore usually occurs when the dip changes from steep to flat.--Auth.

2-3094. Austin, Carl F. **SOME SCHEELITE OCCURRENCES IN THE MAGDALENA MINING DISTRICT OF NEW MEXICO:** New Mexico, Bur. Mines & Mineral Resources, Circ. 55, 17 p., 9 illus., 3 maps, 3 diags., 2 tables, 1960, 6 refs.

The Magdalena mining district of Socorro County has in past years been a major producer of Zn, Pb, and Cu, with the accompanying recovery of minor amounts of Ag and Au. The district presently produces Zn and Pb ores. W minerals have not been reported before in the published literature concerning the district despite many years of mining activity in a geologic setting favorable for the deposition of W minerals.

The Magdalena mining district lies in an area of westward tilted and faulted Carboniferous sedimentary rocks that lie on a Precambrian basement. Over these is a volcanic cover considered, at least in part, to be Tertiary in age. Two known stocks are present, the Anchor Canyon stock, granitic, and the Nitt stock, monzonitic.

The Anchor Canyon stock was found to contain very minor amounts of scheelite as patches or grain in joints in the intrusive rock, indicating that prospecting of the margins of the Anchor Canyon stock for W is warranted. No scheelite was found in or adjacent to the Nitt stock. The bulk of the scheelite discovered to date in the Magdalena district occurs adjacent to the Young America fault in the southern portion of the district. This general area offers distinct possibilities for at least economic byproduct production of scheelite in conjunction with base-metal operations. In addition, the presence of W in the southern portion of the district lends strong support to the concept of a buried stock in that area.--Auth.

2-3095. Derry, Duncan R. **EVIDENCE OF THE ORIGIN OF THE BLIND RIVER URANIUM DEPOSIT** Econ. Geology, v. 55, no. 5, p. 906-927, map, 2 secs., chart, table, Aug. 1960, 25 refs.

The 10 U mines now in production in the Blind River area of Ontario have provided considerable ne evidence on the origin of the deposits and have been the subject of a number of studies by government, company, and research geologists. An attempt is here made to coordinate and assess the evidence and conclusions presented by the various workers.

Commercial ore is almost exclusively restricted to quartz pebble conglomerate beds near the base of the lower Huronian quartzites, and a direct relationship exists between maximum conglomerate development and grade of U. The detrital material was derived from Archean basement rocks to the NW. and was probably deposited under deltaic conditions near a northward-migrating shore line.

The ore minerals are uraninite, brannerite, and minerals of the gummite group in variable proportions. Brannerite is the most generally accepted as detrital mineral but even here the evidence is not altogether convincing. Age determinations show that definite detrital minerals, such as zircon and monazite, have an age corresponding to that of the Archean basement while the U minerals show an age closer to that of the deposition of the lower Huronian sediments

Pending more convincing evidence that the brannerite is detrital, it is concluded that: 1) The U minerals were deposited contemporaneously, or shortly after, deposition of the conglomerate beds, but as precipitates from supergene solution rather than as detrital minerals. 2) The present U minerals resulted from recrystallization or reaction with other minerals after burial. 3) Hydrothermal action does not appear to have played a more significant role than aiding such recrystallization and the redistribution of U within the conglomerate beds.--Auth.

2-3096. Wilson, William H. **RADIOACTIVE MINERAL DEPOSITS OF WYOMING:** Wyoming, Geol. Survey, Rept. Inv. no. 7, 41 p., map, 1960, 117 re

U deposits in Wyoming are known to occur in rock of Precambrian age and at least 33 different formations ranging in age from Cambrian to Pliocene. Most of the current production comes from the Eocene Wind River formation in the Gas Hills area of Fremont and Natrona counties. Additional production comes from the Madison formation (Mississippian) in Big Horn County, the Fall River and Lakota formations (Lower Cretaceous) in Crook County, the Wasatch formation (Eocene) in Campbell, Converse, and Johnson counties, and the Browns Park formation (Miocene?) in Carbon County.

Th and rare earth mineralization in Wyoming occurs in pegmatites and veins in rocks of Precambrian age; in consolidated placer-type deposits of Middle Cambrian, late Cretaceous, and Tertiary ages; and in Quaternary alluvial deposits. Euxenite is mined from a pegmatite in Carbon County.--Auth.

2-3097. Lloyd, Trevor, and David C. Nutt. TRANSPORTATION OF UNGAVA IRON ORE: Can. Geographer, no. 15, p. 26-38, 3 illus., 4 maps, 3 tables, 1960, approx. 15 refs.

This paper discusses a mining project which, when completed, may have profound influence on economic development of the whole Canadian Eastern Arctic. Slowness in developing the region has been due, in large measure, to difficulty of access, particularly in winter. This has been reflected in high transportation costs as compared with areas farther S., or in the same latitude on the western margin of the Canadian Shield.

The most promising location for mining development in the Eastern Arctic in the near future is in the neighborhood of Hudson Strait. Large Fe ore deposits on the W. side of Ungava Bay are well located to satisfy part of the growing demand for steel in the nations bordering the North Atlantic. However, mineral development anywhere in the Eastern Arctic is seriously handicapped by a short navigation season which makes it difficult to carry construction materials and equipment to the sites and to ship the products out to markets. In Ungava Bay, the open season is about 4 months, too short a period to convey sufficient tonnages of ore over the long sea routes to Europe or the eastern United States.

Entirely apart from transportation, there are other problems to be faced in opening up such an entirely undeveloped region to mining, but they are of a type met with and overcome elsewhere. There is, however, apparently no precedent for a mine needing to export several million tons of ore a year over routes in excess of 2,000 mi., but with a shipping season restricted to so few months. The solution in the case of Ungava Bay is to employ an intermediate transfer station in an ice-free area of W. Greenland on the far side of Davis Strait.

The paper describes some of the factors taken into consideration in planning the exploitation of Ungava Fe ore, transportation of the concentrate, and in particular the selection of an ice-free port site in Greenland.

This project will, if successful, pioneer the industrialization of northernmost Quebec, but, of perhaps greater long run significance, it should demonstrate a technique by which other mineral deposits in more remote parts of the Eastern Arctic may be brought to world markets at a competitive cost.--Auth.

2-3098. Gundersen, James Novotny. STRATIGRAPHY OF THE EASTERN MESABI DISTRICT, MINNESOTA: Econ. Geology, v. 55, no. 5, p. 1004-1029, 2 maps, 3 tables, Aug. 1960, 9 refs.

The eastern Mesabi district of Minnesota is economically important because of the current large scale utilization of the magnetite-bearing Biwabik Fe-formation as a source of Fe ore.

The Animikie group of sediments, consisting of the Pokegama, Biwabik, and Virginia formations, were deposited successively over the Giants Range granite. These sediments were subsequently intruded by small diabase bodies and the Duluth gabbro. The 4 well-established members of the Biwabik Fe-formation have been further subdivided into 22 submembers, which are briefly described.

This paper establishes the stratigraphic framework upon which the generalized distribution of minerals of the metamorphosed Biwabik Fe-formation can be presented. The discussion of the metamorphic mineral paragenesis, extensive metasomatic activity and related subjects will be presented in later papers.--Auth.

2-3099. Bertholf, William E., 2d. MAGNETITE TACONITE ROCK IN PRECAMBRIAN FORMATIONS IN RIO ARRIBA COUNTY, NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Circ. 54, 24 p., 2 illus., map, 6 diags., 8 tables, 1960, 5 refs.

In 1959 it became evident that a Precambrian magnetite taconite formation of unknown extent occurs in the Moppin metavolcanic series in Rio Arriba County. Exploratory dip-needle and magnetometer traverses were made, and sparsely distributed outcrops and float rock of the magnetite taconite rock were examined in secs. 19 and 29, T. 29 N., R. 7 E., and sec. 29, T. 28 N., R. 8 E. The aforementioned localities are on the NE. limb of a synclinal structure and are separated by approximately 10 mi. Lower Precambrian formations continue to the SE. on the same structural trend. The magnetite taconite formation examined is within the Carson National Forest.--From introd.

Instrument data, and results of sampling and testing procedures are given. Sections are included on estimate of the Fe potential in Rio Arriba County and on guides to the utilization of potential taconite reserves.

From the results of the present and previous studies, it appears that: 1) A magnetite taconite rock would result from a substantial intrusion of magnetite into the Moppin, Cleveland Gulch, Ortega, Petaca, Badito, and Hondo siliceous or quartzite phases. 2) The quartzitic rock belt in the Hopewell to Dixon area can be traced (or inferred under Tertiary rocks) over a linear strike distance of more than 40 mi. and has a thickness in excess of 5,000 ft. 3) Such an extent of potential quartzitic host rock represents a major environment for the development of magnetite-rich rock masses. 4) In the Hopewell-Kiawa area, the various porphyry intrusives associated with the Tusas granite probably constitute the source of the magnetite. 5) The pattern of outcropping shown on the regional map suggests that the Tusas granite is present under the whole area at moderate depth. 6) Stated simply, an extensive geophysical and geochemical environment exists that is favorable for the impregnation of large quartzitic rock masses with Fe minerals.--p. 18.

2-3100. Greenwood, Robert. AVAILABILITY OF CESIUM FOR ION ROCKETS: Mining Engineering, v. 12, no. 5, p. 482-483, 2 tables, May 1960, 18 refs.

The planning of interplanetary missions has evoked from rocket engineers some radical ideas for propulsion systems, in an effort to attain maximum energy with minimum weight of fuel. Cs is considered desirable for use in ion rockets. Present production, uses, geochemical distribution, and potential ore deposits are discussed.--Auth.

2-3101. Benda, William K., Richard C. Erd, and Ward C. Smith. CORE LOGS FROM FIVE TEST

HOLES NEAR KRAMER, CALIFORNIA: U.S. Geol. Survey, Bull. 1045-F, p. 319-393, 2 maps incl. geol. map (in pocket, scale 1:62,500), logs (in pocket), 3 tables, 1960, 12 refs.

In 1957, 5 test holes were drilled near Kramer, in the western Mojave Desert, for the U.S. Geological Survey. The drill sites are in topographic basins where gravimetric and geologic surveys indicated the presence, beneath alluvium, of a thick section of Quaternary and Tertiary sedimentary and volcanic rocks.

Two holes, which were deeper tests at sites drilled in 1954, cored only silts, sands, and gravels: Four Corners test hole 1 was drilled in sec. 20, T. 10 N., R. 6 W., to a depth of 3,500 ft. Four Corners test hole 2, in sec. 5, T. 10 N., R. 8 W., was drilled to 2,328 ft.

Three holes which were drilled at new sites N. of Kramer Junction, the intersection of U.S. Highways 395 and 466, and locally known as Four Corners, penetrated colemanite-bearing sediments. The location and total depth of these holes are as follows: Four Corners test hole 3, sec. 18, T. 11 N., R. 6 W., depth 2,568 ft.; Four Corners test hole 4, near the N. edge of sec. 30, T. 11 N., R. 6 W., depth 3,500 ft.; Four Corners test hole 5, near the S. edge of sec. 30, depth 1,604 ft. The sections of rocks penetrated in these 3 holes are similar. In each, the colemanite is in fine-grained sediments; these lie below sands and gravels, which are about 600 to 800 ft. thick, and are underlain by sandstones and conglomerates.

Colemanite is most abundant in the cores from Four Corners test hole 5, particularly in the 76 ft. of core recovered between depths of 1,051 and 1,131 ft. Chemical analysis indicates that in this section of core the average content of B_2O_3 is above 14%. In addition to colemanite, the cores contain sulfides of As, an unusual iron sulfide, and zeolites. This mineral content of the colemanite-bearing sediments N. of Kramer Junction (Four Corners), together with the general lithology of the lake beds and the occurrence of the sediments as a tilted section of beds below sands and gravels, supports correlation with the upper or marginal parts of the borate-bearing sediments at the Kramer borate mining district, which have similar features. There is, however, no evidence that any beds are exactly equivalent in age. --Auth.

2-3102. Hoadley, J.W. MICA DEPOSITS OF CANADA: Canada, Geol. Survey, Econ. Geology Ser. no. 19, 141 p., illus., 13 figs. (5 in pocket incl. 3 maps), 22 tables, 1960, approx. 130 refs.

At present mica is not mined extensively in Canada, chiefly because of cheap production in other countries. This report describes the geology, occurrence, and potential of the various mica minerals in Canada. It reviews the status of mica production and gives brief summaries of production in other countries. A considerable portion of the text is devoted to physical properties with special reference to the atomic structure of the minerals of the mica group.--P. Harker.

2-3103. Robinson, G.C., and Henry S. Johnson, Jr. BRICK CLAYS OF MEDWAY PLANTATION, BERKELEY COUNTY, S.C.: South Carolina, State Devel. Board, Div. Geology, Geol. Notes, v. 4, no. 2, p. 8-18, fold. map, 2 tables, March-Apr. 1960.

Field and laboratory investigations of the clays on Medway Plantation indicate an abundant supply of materials ranging from clayey sand to rich plastic clay and marl. Various blends of these materials were found suitable for structural brick, face brick, and lightweight aggregate. Of particular interest is the possibility of making a facsimile of the attractive handmade brick produced at Medway and elsewhere in the South Carolina low country many years ago.

Results of the studies of Medway Plantation clays are applicable to similar clay deposits at many other localities in the lower Coastal Plain of South Carolina --H.S. Johnson, Jr.

2-3104. Burnett, John L. EXPANSIBLE SHALE: California, Div. Mines, Mineral Inf. Service, v. 13, no. 5, p. 1-6, 8 illus., map, May 1960, 16 refs.

Expansible shale is a fine-grained rock, usually of sedimentary marine origin, which will expand when heated under suitable conditions. Potentially economic deposits of expansible shale are found in formations of Jurassic to Pliocene age in the Coast Ranges of northern and central California and the Transverse and Peninsular Ranges of southern California.

The expansion of a shale particle is controlled by many factors, but fusion of the particle and the formation of gases within the particle are of prime importance. Expanded shale is produced at 5 plants in California, all of which employ rotary kilns. Another operation produces a lightweight aggregate by burning an oil-impregnated diatomite in open piles. Expanded shale is used as a lightweight aggregate in concrete and a variety of prestressed and prefabricated structural products. The economic factors to be considered in operating an expanding plant include size and accessibility of markets, local zoning conditions, availability of fuel, and the characteristics of the raw material and product.--Auth.

2-3105. Harrison, Jack L. DIRECTORY OF PRODUCERS AND CONSUMERS OF CLAY AND SHALE IN INDIANA: Indiana, Geol. Survey, Directory 7, 38 p., 4 figs., 1960.

This directory is a revision of Directory 3, published in 1955. Since that time, numerous changes have taken place in the clay and shale operations in Indiana. The clay and shale industry in Indiana is discussed briefly. All producers and consumers of clay and shale are listed both alphabetically and by county. Various facts about each operation are given, namely, location, plant manager, products, firing temperature, fired color, plant capacity, and raw materials. This directory is published as an aid to the clay and shale industry, to citizens of Indiana interested in the clay and shale industry, and to organizations serving the industry.--Auth.

2-3106. McGregor, Duncan J. GRAVELS OF INDIANA: Indiana, Geol. Survey, Rept. Prog. 17, 53 p., 17 figs., pl., 5 tables, 1960.

The geology of gravel in Indiana is related to glaciation. Gravel is found in ice-contact sediments such as kame and esker deposits and in outwash sediments such as outwash-plain and valley-train deposits. The exploration for gravel requires the use of many tools; the most important of these tools are the topographic map, the soil map, and aerial photographs. Combining these 3 tools provides one of the best initial ways of isolating the favorable regions for gravel exploration from the unfavorable regions.

The materials that make up a gravel deposit reflect the parent rock in the source area, the way in which the rock particles were transported, and the depositional environment in which the rock particles were laid down.

The results of the laboratory study of gravel show: 1) the major source area of Indiana gravels is close by the deposit; 2) mechanical breakdown during transportation is a more important factor than chemical solution; 3) gravel deposits do not result entirely from deposition in one transporting medium at any one time; 4) sandstone occurs in larger amounts in kame and esker deposits; 5) no single factor can account for the relationship between particle size and composition; 6) most materials in gravel that make it undesirable for use as gravel aggregate increase in the smaller size in all gravel deposits.--Auth.

2-3107. Furcron, A.S., and Charles W. Fortson, Jr. COMMERCIAL LIMESTONES OF THE FLINT RIVER BASIN SOUTH OF ALBANY, GEORGIA: Georgia Mineral Newsletter, v. 13, no. 2, p. 45-57, 39 figs. incl. 4 illus., 4 maps, Summer 1960, 16 refs.

A reconnaissance study of available limestone in the Flint River area SW. of Albany. Outcrops are not common and the modes of outcrop are related to the physiography. All outcrops described occur on either the Tifton upland or the Dougherty plain. In all, 26 localities are described and located. Chemical analyses for most of the limestones located are given. The rock is used for agricultural lime, building stone, cements, and rock wool manufacture.--J.G. Lester.

2-3108. Financial Post. SURVEY OF MINES, 1960. REVIEW OF MINING ACTIVITIES, COMPANY ANALYSES, PRICE RANGE, PRODUCTION TABLES, MAPS: 372, 32 p., maps, tables, Montreal, Maclean-Hunter Publishing Company, 1959.

The 34th annual survey of the Canadian mining industry. Preliminary matter consists of an index of companies covered, dividends paid by Canada's metal mines, price range of metals, statistical tables of mineral production, price range of mining stocks, milling plants in Canada. Six chapters then list and describe mines in British Columbia; Manitoba; Maritime Provinces; Ontario; Quebec; Saskatchewan, Alberta, Northwest Territories and Yukon. A seventh chapter deals with miscellaneous companies. A 32-p. section at the end of the volume contains maps of Canada's mineral area.

2-3109. Dufresne, A.O. SIGNIFICANCE OF MINING IN THE PROVINCE OF QUEBEC: Can. Geog. Jour., v. 60, no. 6, p. 190-203, 20 pls., June 1960.

In 1956 Quebec had its highest mineral production; $464 million. This figure puts mining among the most important industries of the province. The widespread distribution of mining camps has been an influential factor in increasing prosperity. The successful mining development of the past is an indication of forthcoming progress.--J.A. Chamberlain.

2-3110. Schilling, John H. MINERAL RESOURCES OF TAOS COUNTY, NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Bull. 71, 124 p., 2 pls. (geol. maps, scale 1:59,215, and 1:36,205), 43 figs., 3 tables, 1960, 72 refs.

Taos County has yielded a variety of metals and minerals, and has excellent future possibilities. Early prospecting was mainly for Au and Cu, but production was small. Later, the county became an important producer of Mo, perlite, beryl, Ta, and Li. Smaller amounts of optical calcite, W, scoria, Ag, Pb, Zn, Bi, sand and gravel, and limestone also have been mined.

Precambrian pegmatites and Cu- and W-bearing quartz veins occur in the Picuris and Taos ranges. Deposits of kyanite and sillimanite, graphite, and iron oxides are found in the Precambrian rocks in the mountains. Abundant limestone and a little impure "coal" are found in the Paleozoic sedimentary rocks of the "Tres Ritos hills." Miocene(?) hydrothermal veins and disseminated deposits, mainly in the Taos Range, contain Mo, Cu, Pb-Zn, Au, Ag, and fluorite; disseminated deposits of Mo and Cu may occur in the altered area along the Red River. Au placers are found along the valleys in the Taos Range and along the Rio Grande and its tributaries in the Taos plateau. Pleistocene(?) perlite and scoria deposits are found on the Taos plateau. Sand and gravel are widespread and abundant.

Some of the mineral deposits that have not been mined show possibilities for future profitable exploitation. More detailed study is needed to evaluate such possibilities properly.--Auth. and F.E. Kottlowski.

13. FUELS

See also: Areal and Regional Geology 2-2811; Mineralogy 2-3031; Sedimentary Petrology 2-3060; Mineral Deposits 2-3080.

2-3111. Weeks, Lewis G. THE NEXT HUNDRED YEARS ENERGY DEMAND AND SOURCES OF SUPPLY: GeoTimes, v. 5, no. 1, p. 18-21, 51-55, 3 graphs, 9 tables, July-Aug. 1960, 3 refs.

The probable sources of energy to be used in the next 100 years include several in wide use now - oil, gas, coal, wood, water, and farm wastes. Other sources such as nuclear, solar, and geothermal, have yet to be fully perfected.

The energy demand from all sources in the next 100 years will be approximately the equivalent of 44,030 billion barrels of oil. In 100 years nuclear, solar, and geothermal energy should account for nearly 40% of the world's-energy demand.--M. Russell.

2-3112. Russell, William L. PRINCIPLES OF PETROLEUM GEOLOGY: 2d ed., 503 p., illus., maps, secs., diags., graphs, tables, New York, McGraw-Hill, 1960, approx. 600 refs.

This book is intended to serve as a text and reference volume for geologists. It covers the whole field of petroleum geology and does not emphasize certain aspects at the expense of others. Petroleum engineering is entirely omitted, and a minimum of space is given to structural geology. Because of the number of subjects, the treatment of each has been concise and general rather than detailed. Descriptions of particular oil and gas fields have been avoided, except as illustrations of types and processes.--From auth. pref.

The new edition has been revised, much new material added, and information brought up to date. The first 17 chapters deal with principles; the remaining 12 chapters cover the specialized methods or techniques used by petroleum geologists. The following subjects are dealt with: science of petroleum geology; subjects related to petroleum geology; chemistry of natural hydrocarbons; physical properties of petroleum; oil-field waters; methods of representing geological conditions; structures important in petroleum geology; reservoirs and reservoir rocks; classification of traps for oil and gas accumulation; subsurface pressures; origin of petroleum; migration and accumulation of oil and gas; relation of oil and gas production to incipient metamorphism of sediments; relations of oil and gas fields to unconformities; depositional features; surface indications; salt domes; lithologic well logs; electrical well logs; radiation or nuclear well logs; correlation of well logs; use of geochemistry in the search for oil and gas; magnetic, gravimetric, and electrical geophysical methods; geophysics - seismic methods; development of oil and gas fields after discovery; summary of methods of locating stratigraphic traps; search for oil on continental shelves; appraisal of oil and gas prospects; future of petroleum geology.

2-3113. Gatlin, Carl. **PETROLEUM ENGINEERING, DRILLING AND WELL COMPLETIONS:** 341 p., illus., maps, secs., diags., graphs, tables, Englewood Cliffs, New Jersey, Prentice-Hall, 1960, refs.

A textbook which attempts to present an integrated picture of drilling and well completion operations as they are normally encountered by the petroleum engineer. In order to do this without assuming prior knowledge in the field, it was necessary to introduce a number of general topics such as reservoir fluid properties, reservoir rock properties, exploration and leasing practices, core analysis, well logging, and formation damage. By including the necessary background material this text may be used in a first course, and, with some selection and deletion, it may serve the needs of a more advanced course. The volume is primarily concerned with operational procedures and not with detailed descriptions and analysis of equipment.--From auth. pref.

The 15 chapters deal with the following subjects: nature of petroleum; concepts of petroleum geology and basic rock properties; petroleum exploration methods and general leasing practices; cable tool drilling; rotary drilling; factors affecting penetration rate; coring and core analysis; well logging; formation damage; drill stem testing; well cementing and casing practices; well completion.

2-3114. Neavel, Richard C., and G.K. Guennel. **INDIANA PAPER COAL: COMPOSITION AND DEPOSITION:** Jour. Sed. Petrology, v. 30, no. 2, p. 241-248, 7 illus., 2 maps, graph, 3 tables, June 1960, 9 refs.

The term "paper coal," previously applied to a coal in the U.S.S.R., describes a coal found in Parke County, Indiana. In contrast to the Russian coal, which consists of cuticles of arborescent lycopods, the cuticles of the Indiana paper coal resemble Sphenopteris bradfordii Arnold, the foliage of a seed fern.

Exinite (cuticles and spore exines) constitutes 23.5% of the coal seam where it is unweathered. The papery texture occurs only where weathering has removed the vitrinite and has left a mat of resistant cuticles.

Spore analyses indicate that the seam is one of the upper Pottsville coals. Many sporangia from the paper coal are composed of small, round nonsutured spores and an outside layer of spores resembling Torispora Balme.

Cutinization suggests that these plants could stor water. Fresh water periodically feeding into a saline swamp could have been adequate to sustain these xerophytic plants. Trace element analyses substantiate the belief that water conditions were predominantly marine.

Cutinite isolated from the coal has a calorific value of 16,700 B.t.u. per lb. and a volatile matter content of 85% on a dry, ash-free basis. Because cutinite has such a high volatile matter content, similar cuticular coals possibly can be utilized mos efficiently as hydrocarbon sources.--Auth.

2-3115. Sanford, Robert M., and Fredrico W. Lange. **BASIN-STUDY APPROACH TO OIL EVALU TION OF PARANÁ MIOGEOSYNCLINE, SOUTH BRA ZIL:** Am. Assoc. Petroleum Geologists, Bull., v. 44, no. 8, p. 1316-1370, 18 maps, 3 charts, 3 secs Aug. 1960, 75 refs.

In addition to the Brazilian part of the Paraná bas this paper includes geologic data on the sedimentary basin extension into the neighboring countries of Argentina, Bolivia, Paraguay, and Uruguay, and als briefly discusses the geological development of the Bolivian Andean and the Argentinian Andean, Pampean, and Patagonian regions. The entire area thus studied lies between lat. 16° and 40° S., and betwee long. 46° and 70° W. The present area of the basin is approximately 1,200,000 sq. km. in Brazil alone; at various geologic ages the sedimentary basin embraced several times this area in S.-central South America.

Only those stratigraphic units are described whic are of interest as petroleum sources or reservoirs, or which had a bearing on the tectonism of the basin. These are the Devonian marine series, the Lower Pennsylvanian glacials and marine transgressions, the Upper Pennsylvanian coal-bearing beds and marin transgressional deposits, the lower Permian group with the bituminous shales, the upper Permian grou with brackish to fresh-water formations, the Upper Triassic continental eolian deposits, and the Juro-Triassic extrusive lavas and intrusive diabase dikes and sills. The section on paleogeography is accompanied by paleogeographic and environment maps fo many of the discussed stratigraphic units.

Early geologic history of the Paraná basin is traced, mainly for background reference, from the great geosynclinal troughs and mountain-building periods of early Precambrian, through the equivalents of the Laurentian, Penokean, and Taconic revolutions, to the Caledonian revolution at the end of the Silurian. Late Silurian outlined the general framework of the Paraná basin and defined the limits of its subsequent oil prospective deposits of middle and upper Paleozoic and Mesozoic sediments.

The widespread deposits of black, marine, bitum inous shales of lower Devonian are overlain unconform ably by the successive cycles of glacial deposits of the lower Pennsylvanian age. These glacial sheets covered nearly the entire southern part of the continent. At least 5 distinct glacial advances from the S., with marine transgressions from the W. and the NW. during the interglacial epochs, have been identified.

General epeirogenic fluctuations of the basin wer responsible for the shallow-water type of deposition during upper Pennsylvanian and Permian time. Lower Mesozoic is represented by a period of eolian sand deposition, giving way in Rhaetic timê to the great, deep fractured lava flows. These geoclases probably reached the salsima magmatic zone and caused the decompression of the basic magma chambers and the subsequent ascension of lava which, in successive flows, spread over the entire region of central South America in thicknesses up to 1,500 m.

In the northern part of the basin supra-basaltic eolian sands were deposited during the Jurassic, followed by Upper Cretaceous fluviatile and limnic deposits. During Tertiary, epeirogenic movements uplifted the Brazilian coastal shield, the elevation of the old mountain ranges being accompanied by faulting. Cenozoic deposits are represented by small and restricted flood-plain basins and by marine coastal deposits. The paleogeographic development of the neighboring countries is also briefly discussed. The study then deals with the principal structural features and finishes with a discussion of the favorable areas and oil possibilities.

A combination of 1,200 m. of nonbedded glacial deposits and 1,500 + m. of extrusive lava deposits within a 4,500 - m. section comprising also marine and eolian deposits at once renders normal methods of geological and geophysical exploration rather ineffective. Though the individual lava flows can be determined, they cannot be effectively mapped by surface geologic methods over the vast area of outcrop. Neither is the seismic method of geophysical exploration effective since the energy of the charge is dissipated before reaching the base of the lava, even with a multi-hole shot pattern. Long reconnaissance gravity lines across the basin have given some indications of relative lava thicknesses but are not effective for detailed studies of deeper strata.

In résumé the stratigraphic sequence demonstrated that, though the section cannot be considered of prime favorability for oil generation and accumulation, it does offer sufficient possibilities to merit exploratory drilling. The numerous oil seeps of southern Brazil, most of which originated from sediments of the same age of those producing in the N. Argentinian and southern Bolivian oil fields, enhance the oil possibilities of S. Brazil and do warrant continued exploratory investigations.

The factors considered as unfavorable to migration, accumulation, and possible production of oil may be summarized as: a) lack of anticlines or folded structures, b) very low regional dips, c) no thrust or reverse faulting and d) the indication that the many epeirogenic subsidences which could have caused generation, migration, and accumulation of oil, also could have caused the oil to have been spilled from its trap, thereby allowing its updip escape to the outcrop.

The favorable factors are: a) possibility that some hingeline oil still remains in fault traps along the present outcrop line, b) a strong possibility that any Pennsylvanian or Permian generated oil did not migrate until, or after, the overburden of the basaltic lava, thus being accumulated in fault blocks against diabase dikes, c) oil which may have been released for upward migration along dike lines after the lava flow may be accumulated in the eolian Botucatú sandstone underlying the lava cap (one outcrop occurrence known).

Regarding actual oil possibilities, an oil occurrence and specific gravity map was made to show the origin, movement and final accumulation of liquid hydrocarbons throughout the entire Paraná basin and adjoining sub-Andean area. The conclusions drawn from that map are 1) the contact zone of lower Pennsylvanian and Devonian is responsible for most of the oil seeps in both the Bolivian sub-Andean area and in the Paraná basin, and 2) almost all of the Paraná basin oil seeps are on the supposed eastern hingeline of the basin. It is further significant that the eastern hingeline nearly approximates the assumed subcrop limit of present-day Devonian bituminous shale beds. This enhances the probability that any oil found in Paraná basin will probably be Devonian generated and both Devonian and Pennsylvanian reservoired oil.--Auth.

14. ENGINEERING GEOLOGY

See also: Areal and Regional Geology 2-2805; Geomorphology 2-2836; Igneous Petrology 2-3039; Sedimentary Petrology 2-3043.

2-3116. Neilson, James M., A.K. Snelgrove, J.R. Van Pelt. CURRICULAR AND PROFESSIONAL ASPECTS OF GEOLOGICAL ENGINEERING: Econ. Geology, v. 55, no. 5, p. 1048-1059, chart, Aug. 1960, 11 refs.

The geological engineering curriculum, recognized for over 30 years by the Engineers' Council for Professional Development, is still suspect in some quarters because of its relative emphasis on basic rather than engineering sciences.

An interdepartmental committee of broad scope at the Michigan College of Mining & Technology has spent a year on a critical study of the make-up of the curriculum in question with a view to putting it on a firmer basis within the engineering profession as well as within the geological fraternity. This article endeavors to define adequately the scope and function of the geological engineer. To improve the integration of engineering and geology and to establish the validity of this discipline, a quantitative portrayal is advanced of the impingement of each on the other. --Auth.

2-3117. California Association of Engineering Geologists. PROGRAM, 1959. 2ND ANNUAL MEETING, OCTOBER 9 AND 10, FIELD TRIPS, OCTOBER 11: 28 p., maps, Los Angeles, University of Southern California, 1959.

This meeting, held at the University of Southern California, included a technical session, a symposium on engineering geology in the nuclear age, and field trips to Pacific Palisades-Malibu Landslides and Ridge Basin. Road logs for the field trips appear on p. 23-28. The program includes abstracts of papers given at the technical session (p. 4-13). Papers are listed below:

Amimoto, P.Y. Permeability Graphs in Drill Logs.

Bean, Robert T., and David M. Hill. Investigation of Crustal Strain in California.

Clements, Thomas. Graduate Program in Engineering Geology at the University of Southern California.

Curtin, George. Water Testing Semi-Consolidated Sediments of the Tehama Formation, Sacramento Valley.

Eagen, Jack T., and Douglas R. Brown. Settlement in the Los Angeles Basin.

Ellis, William C. Continuous Electrical Resistivity Logging of Canals.

Foster, John W. Modern Water Well Design - A Blend of Geology and Engineering.

Fuqua, Wallace D. Status of Shallow Land Subsidence Studies by Department of Water Resources in Western and Southern Parts of the San Joaquin Valley, California.

Nelson, Jerome S. Geophysical Applications in Engineering Geology.

Richter, Raymond C. Hydraulic Structures in California Damaged by Earthquake Activity.

Thomas, G.H. The Problem of Differentiating the Quaternary Sediments in Greater Los Angeles Basin.

Thomas, Robert G. Quantitative Ground Water Geology.

Treasher, Ray C. Engineering Geologic Conditions, San Francisco Bay Studies.

Papers presented at the symposium, summaries of which are printed in the program (p. 14-22), were:

Eckel, Edwin B. Opportunities and Responsibilities of Engineering Geologists in the Nuclear Age.

Shoemaker, Eugene M. Geological Exploration of the Moon.

Bascom, Willard. Drilling Beneath the Ocean.

Violet, Charles E. Phenomenology of Underground Nuclear Detonations.

Smith, Sherwood B. Some Engineering Considerations in the Design of Tunnels and Chambers to Resist Effects of Underground Nuclear Explosions.

Garrick, B. John. Some Hydrologic and Geologic Considerations in Reactor Site Selection.

Jaffe, Nanette, and Roland Carlson. Industrial Application of Nuclear Explosives and Their Relation to Engineering Geology.

Thompson, Thomas F. The Engineering Geologist in Peace Time Applications of Atomic Energy.

2-3118. Church, H.K. CLASSIFICATION OF EXCAVATION BY LAYER METHOD WITH PORTABLE REFRACTION SEISMOGRAPH: Southwest Builder & Contractor, v. 135, no. 24, p. 90-97, 6 figs, 1960, 3 refs.

In estimating costs or planning an excavation it is necessary to classify the materials that are to be moved and to estimate the quantities of each class. Rather than using geologic classifications, or the orthodox "common" and "rock" and "unclassified" categories, earth and rock movers are commencing to classify the earth's crust directly in terms of conventional methods of using earthmoving machinery. The portable refraction seismograph provides basic data related to consolidation and depth of various layers of rock and soil. Thus seismic velocities can be correlated directly with applicable earthmoving methods. Experience, knowledge of the local geology, and comparison with excavation jobs in similar or nearby materials, are required in addition to seismic studies.--E.B. Eckel.

2-3119. Leet, L. Don. VIBRATIONS FROM BLASTING ROCK: 130 p., 70 figs. incl. illus., secs., diags., logs, 12 tables, Cambridge, Massachusetts, Harvard University Press, 1960, refs.

In covering the subject of vibrations caused by detonations of explosives in rock, such factors are covered as: characteristics of rock, the preparation of blasts, events during and after detonation, and the nature of explosives. Methods are described of recording waves in the earth and their significant features; criteria for estimating their ability to damage structure are presented. Unique features of motion within the potential crater zone, and the use of impedance ratios to achieve maximum blasting efficiency are described. As vibrations are minimized when the energy of blasting is most completely utilized in breaking rock, it follows that thorough study of vibrations provides an indirect measure of blasting efficiency. The chapter headings are: outline of factors involved; explosives and blasting caps; rocks; rupture of rock by blasting; the elastic-wave pattern; safe limits for structures; observations.--M. Russell.

2-3120. U.S. Atomic Energy Commission. PRELIMINARY REPORT, OPERATION HARDTACK, PHASE II. EVALUATION OF BLAST AND SHOCK EFFECTS ON TUNNEL SUPPORT STRUCTURES. By A.A. Lee and E.Y. Wong: Its: [Pub.] ITR-1714, 37 p., illus., May 1959.

The underground nuclear test program of Operation Hardtack, Phase II, provided an opportunity to obtain test information on the effects of underground nuclear detonations on tunnels and tunnel linings. Rock breakage and tunnel lining response informatio was obtained by normal surveying methods, still and high-speed photography, and deflection gage instrumentation. From the limited data available it was concluded that the stress field produced by an underground nuclear detonation in tuff acts essentially as a hydrostatic load around the tunnel which would permit the use of simplified design loading for tunnel linings. The configuration of the tunnel at the zero point influences the damage-distance relationships to a large degree. The straight-end configurations produced a greater damage than the hooked-end configuration. The damage-distance relationships based on previous test (Rainier) for determining the point of closure and the point of no damage are in close agreement with results obtained from a test in a tunnel with similar hooked-end configuration. Though the damage-distance factor for straight-end tunnels is much larger, there is also a large difference in this factor between the 2 events which took place in tunnels with this configuration. Hence, no firm damage-distance criteria have been developed for tunnels with a straight-end configuration. --Auth. (courtesy Nuclear Science Abstracts, v. 14, no. 3, p. 297, Feb. 15, 1960. Publication not seen by AGI).

2-3121. U.S. Atomic Energy Commission. PRELIMINARY REPORT, OPERATION HARDTACK, PHASE II. SUMMARY REPORT OF STRONG MOTIO MEASUREMENTS, UNDERGROUND NUCLEAR DETONATIONS. By W.M. Adams, P.L. Flanders, W.R Perret, R.G. Preston, and D.C. Sachs: Its: [Pub.] ITR-1711, 80 p., illus., maps, diags., graphs, 25 tables, Jan. 1960, 23 refs.

Subsurface and surface motion measurements were made on 6 underground nuclear detonations in the Oak Springs tuff of Nevada Test Site on Operation Hardtack II [1958]: Shots Mars (~13 tons), Tamalpais (~72 tons), Neptune (~90 tons), Logan (~5 kt), Evans (~55 tons), and Blanca (~19 kt). Free-field peak radial acceleration decreased as the inverse third o fourth power of slant range, as for Rainier. Particle velocities attenuated at a rate between the inverse square and inverse cube. Maximum radial and tangential subsurface stress varied as the inverse cube of radial range. Observed peak strain suggested attenuation at a rate between inverse cube and inverse square of range. Maximum upheaval at Blanca surface zero was about 25.5 ft.; 2.5 ft. at 750 ft. radial range; and 1.5 ft. at 910 ft. Reed gage spectra indicated a shift of maximum energy to lower frequencies with increasing ground range. All components of surface acceleration followed an empirical equation of the form

$$A(g) = 3.2 \times 10^{6} W^{0.7} (\text{kt.})\ R^{-2} (\text{ft.}).$$

All components of surface displacement did not follow a comparable relationship. Displacement is more precisely predicted than acceleration. The velocity of the tuff was determined to be 6,200 ft./sec., with the velocity of the underlying dolomite 11,700 ft./sec. The crust at Nevada Test Site has a velocity of 6.58 km./sec. and a thickness of ~30 km. The top of the mantle has a velocity of 8.08 km./sec. and dips eastward.--Auth.

2-3122. [Handy, Richard L.] ELECTRICAL DRAINAGE OF SOILS: Iowa State Univ., Eng. Expt. Sta., Screenings Soil Research Lab., v. 4, no. 1, 6 p., 16 figs., Jan.-Feb. 1960, 3 refs.

Purely electrical movement of water is no mere laboratory curiosity; it is a field curiosity as well. Electro-osmosis will de-water fine silty and clayey soils that cannot be drained by ordinary means.

Discovery of electro-osmosis in 1807 by Reuss, laboratory experimentation by Wiedemann and Quincke, and theoretical treatment by Helmholtz and Smoluchowsky, led to an equation relating water movement to applied voltage, dielectric constant, capillary length and radius, viscosity, and zeta potential. Conflicting views of zeta potential and the double layer are presented.

Applied electrical potential causes cations in the circumferential double layer inside capillaries to move towards the cathode, dragging along absorbed water molecules. Movement of the double layer films drags along much free water as well, increasing efficiency many-fold.

The first practical field trial was conducted by Dr. Leo Casagrande in a railroad cut in northern Germany in 1939. Well points were driven, and made 180 volts negative relative to half-inch pipes driven half-way between. The excavation area was stabilized in one day. The total energy consumption was 1 kwh. per cu. yd. of earth removed. Other trials in the 1940's include a U-boat pen at Drontjem, Norway. Recent jobs in America at Joppa, Illinois; Bay City, Michigan; and Marathon, Ontario, are illustrated and described.

Analogy is drawn between the Helmholtz equation and the Poiseville equation for gravity flow of water in capillaries. Factors affecting electro-osmotic drainage include electro-osmotic coefficient of permeability, usually 0.2 to 0.7 cm./sec. for 1 v./cm., and identity of the mobile cations. Rollins' experiments at Iowa State University showed that with kaolin clay the order of effectiveness is Al>Na>Ca>Fe>H. Al anodes cause irreversible hardening of clay in the immediate vicinity of the anode, suggesting use as friction pile. Electro-osmosis greatly increases consolidation rates of soils under load, perhaps due to pore water tension.--Auth.

2-3123. Colorado School of Mines, Soil Mechanics Conference, 1st, Golden, 1959. THEORETICAL AND PRACTICAL TREATMENT OF EXPANSIVE SOILS: Colorado School Mines, Quart., v. 54, no. 4, 168 p., illus., diags., graphs, tables, Oct. 1959, refs.

This volume is the record of a conference held at the Colorado School of Mines, April 23, 1959, on a topic of growing interest and importance in the field of soil mechanics. There is a brief introduction by T.A. Kelly and a record of the final discussion period at the end of the conference (p. 157-168). The main part of the volume consists of 5 papers on various practical and theoretical aspects of the subject. Two of these, which discuss soil mechanics principles only, are as follows: Lambe, T. William, and Robert V. Whitman. The Role of Effective Stress in the Behavior of Expansive Soils, p. 33-66; McDowell, Chester. The relation of Laboratory Testing to Design for Pavements and Structures on Expansive Soils, p. 127-153.

The other 3 papers, which touch on geology in relation to soils, are separately abstracted below. --E.B. Eckel.

2-3124. Means, R.E. BUILDINGS ON EXPANSIVE CLAY (In: Colorado School of Mines, Soil Mechanics Conference, 1st, Golden, 1959. Theoretical and Practical Treatment of Expansive Soils: Colorado School Mines, Quart., v. 54, no. 4, p. 1-31, 31 figs., Oct. 1959) ref.

Cohesive soils and clays differ from noncohesive soils in the properties of their constituent minerals and differences in shape of the mineral grains. Swelling of clays is due to addition of water in capillary tubes between the particles; shrinkage is caused by removal of this water, either by evaporation or by compression. During a drought evaporation from the surface lowers the top of the capillary fringe toward the water table; the dry clay above this fringe is then subjected to maximum shrinkage. After a rain, free surface water is pulled downward, and the capillary zone above the water table rises. When the 2 saturated zones meet, the capillary tension in the pore water is relieved, and the clay can begin to swell against the reduced pressure. Swelling can take place only after saturation, and saturation is a very slow process, hence clays in some climates never reach maximum swell because wet periods are too short.

When a building is erected on clay, evaporation is retarded, but the soil can become saturated with capillary water drawn up from below. Expansion can thus occur even during dry periods. Around the periphery of a building which loads the soil to pressures less than the maximum capillary pressure, changes in climate and application of water to the surface may cause periodic swelling and shrinking of clay, with consequent damage to the building. The paper contains numerous examples of damage to buildings from expanding clays with suggested or actual methods of prevention or control of damage. All examples have to do with the highly overconsolidated Permian clays of Oklahoma.--E.B. Eckel.

2-3125. Dawson, Raymond F. MODERN PRACTICES USED IN THE DESIGN OF FOUNDATIONS FOR STRUCTURES ON EXPANSIVE SOILS (In: Colorado School of Mines, Soil Mechanics Conference, 1st, Golden, 1959. Theoretical and Practical Treatment of Expansive Soils: Colorado School Mines, Quart., v. 54, no. 4, p. 66-87, 13 figs. incl. illus., diags., graph, 2 tables, Oct. 1959).

Plasticity of a clay influences its swelling and shrinkage, but this index cannot be used as a guide for damage to structures because under certain climatic conditions any clay will cause trouble. In many areas, climate is a more important factor than type of clay; it is believed that with sufficient data it should be possible to establish a relationship between plasticity index and climatic condition. Several examples of experience with building on the Del Rio clay in the vicinity of Austin, Texas, are recorded, with emphasis on soil type, plasticity index, and climate and their relationship to damage to structures.--E. B. Eckel.

2-3126. Holtz, Wesely G. EXPANSIVE CLAYS - PROPERTIES AND PROBLEMS (In: Colorado School Mines, Soil Mechanics Conference, 1st, Golden, 1959. Theoretical and Practical Treatment of Expansive Soils: Colorado School Mines, Quart., v. 54, no. 4, p. 89-125, 22 figs., incl. illus., map, diags., graphs, 2 tables, Oct. 1959), 7 refs.

In the western part of the United States more and more attention is being given to unique foundation conditions associated with the expansion and shrinkage of certain clay soils and clayey bedrock materials . The clay minerals, which change volume with changes in moisture and loading, often present complex problems for canal and highway subgrades and structure foundations. While the problems are most serious when light loadings and large soil moisture changes are involved, movements of moderately loaded structures with expansive clay foundations subject only to seasonal ground moisture changes may be greater than allowable, unless special precautions are taken. This paper includes, for background information, a brief review of identification procedures and research findings previously published. This is followed by information on additional research data and field findings accumulated since 1953, including modifications to the original identification criteria. Volume change and shear strength properties, and factors influencing these properties, are discussed, and comparisons of these properties for expansive materials from numerous areas throughout the West are given. A considerable portion of the paper is devoted to a discussion of job problems for both hydraulic and nonhydraulic engineering works and buildings. Expansive subsoil conditions encountered in Colorado and the Denver area are included in the discussions. A significant feature of the paper is that the facts on physical properties of clays are related to their mineralogy and to the geologic formations in which they occur.--From auth. synopsis and E.B. Eckel.

2-3127. U.S. Bureau of Reclamation. TECHNICAL RECORD OF DESIGN AND CONSTRUCTION. NIMBUS DAM, POWERPLANT, AND FISH HATCHERY, CONSTRUCTED 1952-1955: 213 p., 103 figs. incl. illus., maps, secs., charts, diags., graphs, tables, Denver, Colorado, Aug. 1960, 14 refs.

This technical record is divided into 5 chapters. Chap. 1 contains discussions on general planning, description, and cost data. Chap. 2 covers geology; Chap. 3 is devoted to discussions of the design of the various structures, except the fish hatchery; and Chap. 4 contains factual information on major construction contracts. A comprehensive narrative of the construction is included in Chap. 5.

Nimbus Dam and Powerplant are located on the American River below and W. of the confluence of the N. and S. forks of the American River, about 6 mi. downstream from Folsom Dam and Powerplant, about 4 mi. downstream from the town of Folsom, California. The immediate purpose of the gravity overflow weir type dam is to create an afterbay for regulation of the flow of water released through Folsom Powerplant into the American River. Future purposes of the dam, in addition to the above, are to divert American River water into Folsom South Canal and to provide for pumping water into Folsom North Canal for irrigation purposes.

The site for Nimbus Dam was selected in an area downstream from Folsom Dam where the river valley narrows and the N. bank of the river is formed by a high steep cliff of the Mehrten formation [Miocene and Pliocene(?)] consisting of highly lenticular layers and interbeds of sandstone, siltstone, claystone, conglomerate, and mudflow breccias. Since the dam and the powerplant are both founded on this Mehrten formation, no major construction difficulty or percolation difficulty was anticipated even though the river alluvium is highly pervious.--M. Russell.

15. MISCELLANEOUS

2-3128. Harris, Chauncy D., and Jerome D. Fellmann, comps. INTERNATIONAL LIST OF GEOGRAPHICAL SERIALS: Chicago, Univ., Dept. Geography, Research Paper no. 63, 194 p., June 1960.

This list is the third edition of a comprehensive checklist of serial publications of primarily geographic content, both those currently appearing and those which have ceased publication. The second edition appeared in 1950. Serials in geomorphology and cartography have been included. The list is arranged alphabetically by countries according to the English version of the individual country name. Within each country, entries are listed in alphabetical order of titles or issuing agencies. A symbol indicates whether the serial was actively current as of Apr. 1, 1960.--From auth. introd.

2-3129. Ross, Clyde P. ANNOTATED BIBLIOGRAPHY OF PAPERS RELATED TO THE GEOLOGY OF IDAHO 1941-1957: Idaho, Bur. Mines & Geology, Pamph. no. 119, 219 p., 1959.

2-3130. Tomkeieff, S.I. THE PROGRESS OF GEOLOGY IN THE U.S.S.R.: GeoTimes, v. 5, no. 1, p. 22-25, 45-50, July-Aug. 1960; no. 2, p. 8-14, 38-39, Sept. 1960, refs.

This brief survey of the development of geology and of the teaching of geology in the Soviet Union is the first of its kind in English and is intended merely to introduce the subject and to induce English geologists to learn Russian and so make available for themselves the immensely rich scientific resources of the U.S.S.R., or failing that, to make themselves acquainted through the medium of abstracts and translations with the geological work being done in the U.S.S.R.

The article is intended as a guide, and it comprises sections dealing with the history and multifarious branches of geology as it exists in the 1950's There is space only for major developments in the organization of teaching and research and for outstanding contributions to the science of geology, associated generally with the names of the principal

eologists of the U.S.S.R. The article also includes
ery brief bibliographical references.--Auth. summ.

-3131. American Geological Institute. THE GEO-
OGICAL SURVEYS OF THE WORLD: Its: AGI Data
heet 14 rev., 2 p., in GeoTimes, v. 5, no. 1, p.
3-34, July-Aug. 1960.

A revision by the American Geological Institute
f GeoScience Abstracts 1-2397. In preparing the
evision, the geological surveys of the world were
ontacted to verify proper names and addresses of
e organizations. No attempt has been made to list
tate and provincial surveys. Names and addresses
re given for 119 national surveys grouped as follows:
orth America - 4, Central America and Caribbean
slands - 10, South America - 13, Europe - 27,
frica - 34, Middle East - 10, Asia - 15, Australia
nd Pacific Islands - 6.

-3132. STATE GEOLOGISTS JOURNAL, v. 12,
o. 1, 127 p., Apr. 1960.

The journal is devoted to information concerning
e organization, facilities, activities, accomplish-
ents, and publications of the various geological sur-
eys and mining bureaus of the states. News and
ecent activities are recorded from 22 states; the
xpenditures of 43 state surveys are tabulated. A
rectory of 46 state geological surveys gives the
ame of the person in charge, the address and tele-
hone number of the headquarters, the number and
nd of staff, and a listing of current projects; a
rectory of Canadian surveys lists the person in
harge and address of the headquarters. The 1959
ublications of 44 state surveys are listed; they total
ore than 500.
The minutes of the 51st annual meeting of the
ssociation of American State Geologists, Apr. 13-
, 1959, Lawrence, Kansas, are here recorded.
A metal, mineral, and mineral fuel review for
959, by the staff of the U.S. Bureau of Mines, re-
orts on Al, Sb, As, Be, B, Cd, Cs, Rb, Cr, Co,
, Ta, Cu, Ga, Ge, Au, He, Pb, Li, Mg, Mn, Hg,
o, Ni, Pt-group, Se, Ag, S, Te, Th, Sn, Ti, W, U,
Zn, Zr, Hf, Pennsylvania anthracite, bituminous
al and lignite, asbestos, barite, bauxite, carbon
ack, cement, clays, diamonds, feldspar, fluorspar,
raphite, gypsum, mica, natural gas and natural-gas
quids, perlite, crude petroleum, phosphate rock,
tash, rare earths, sand and gravel, Fe ore, steel
d stone.--M. Russell.

3133. New Mexico, Bureau of Mines and Mineral
esources. BIENNIAL REPORT FOR THE FISCAL
EARS ENDING 30 JUNE, 1959, AND 30 JUNE 1960,
Alvin J. Thompson: 37 p., 8 illus. (3 col.), 2
aphs, 3 tables, Socorro, Oct. 1960, 54 refs.

This biennium closed a decade of remarkable
owth in mineral production in New Mexico. The
lue of the minerals produced in the state increased
om an annual rate of $200 million in 1950 to $650
illion in 1960. The continued rise of U and petro-
um production, and the establishment of the first
ment and first gypsum plants in New Mexico were
e chief important industrial developments during
e biennium.
Active projects include 35 geologic and ground-
ater studies and 6 metallurgical investigations.
press or published during the 2-year period were
bulletins, 4 memoirs, 4 circulars, 3 "scenic
ps" geologic guidebooks, and 6 maps in the geologic map series of 30-min. quadrangles. Technical publications in outside journals or guidebooks totaled 23. The majority of the 14-man professional staff has been with the Bureau for more than 8 years; their experience and specialized knowledge of the state's geology and mineral resources has become a "factual resource" of New Mexico.--F.E. Kottlowski.

2-3134. Kottlowski, Frank E. GEOLOGIC RESEARCH IN NEW MEXICO DURING 1959: New Mexico, Bur. Mines & Mineral Resources, Circ. 56, 44 p., 1960, approx. 140 refs.

Geologic research projects pursued in New Mexico during 1959 totaled (with considerable grouping) 189, involving 159 workers and 41 organizations. Areal geologic mapping and ground-water studies led with 35 projects each, followed by stratigraphic investigations (19), and studies of metallic deposits (18). The northwestern quarter of the state was the most intensively studied, followed in order by the southwestern, southeastern, and northeastern quarters. Of the 159 geologists reporting, 79 were based within New Mexico, and 80 came from areas as far away as California and New York; the largest of these out-of-state workers were Federal employees from Denver. As shown by a survey of the major geologic journals, this geologic research resulted in at least 87 papers and 44 abstracts relating to facets of New Mexico geology.--Auth.

2-3135. Weihaupt, John G. VICTORIA LAND TRAVERSE, ANTARCTICA, 1959-60: Arctic, v. 13, no. 2, p. 135-136, June 1960.

The purpose of the note is to make available general information of the Victoria Land traverse and its outcome. The traverse party left Scott Base, Antarctica, on Oct. 16, 1959, and was evacuated from the field on Feb. 10, 1960, after covering 1,530 mi. of largely unexplored territory. A new mountain range, the Arctic Institute Range, and the sizeable Rennick Glacier were discovered.--Auth.

2-3136. Aune, Quintin A. THE GEOLOGIC MAP: California, Div. Mines, Mineral Inf. Service, v. 13, no. 8, p. 1-8, 8 figs. Aug. 1960, 13 refs.

The geologic map is described for the layman. Its uses, preparation and development are discussed. Methods are suggested that may help the layman read and interpret such a map. Two figures illustrate the measurement of rock orientations shown by symbols on a geologic map, and 3 figures illustrate geologic structures and the symbols used to represent them on geologic maps.--Auth.

2-3137. MAPS FOR MOON LANDING: Sci. News Letter, v. 78, no. 9, p. 131, Aug. 27, 1960.

This briefly describes 3 maps and a table, produced by the U.S. Geological Survey for the U.S. Army Corps of Engineers, analyzing the surface features of the moon. One map shows the physiographic regions of the moon, another a photogeologic map, and the third delineates the lunar rays. The table includes an evaluation of the probable difficulties in landing, movement, and construction.--M. Russell.
The maps are listed in Sec. 1, Pt. 1, Geologic Maps, of this issue of GeoScience Abstracts.

2-3138. Lueder, Donald R. AERIAL PHOTOGRAPHIC INTERPRETATION: PRINCIPLES AND

APPLICATIONS: 462 p., illus., maps, diags., tables, New York, McGraw-Hill, 1959, 233 refs.

In 3 parts, each 8 chapters in length. Pt. 1, Principles and Theories of Photointerpretation, covers explanation of aerial-photographic interpretation; origin, landform, rock type; surface-drainage patterns; erosion features; gray tones; miscellaneous elements; background-training, experience; final interpretation. Pt. 2, Lexicon of Geomorphology and Landforms as Seen by the Aerial Photograph, deals with fluvial, marine and lacustrine, glacial, glaciofluvial, and aeolian landforms; organic-mineral complexes; rock types. Pt. 3, Applications of Aerial-Photographic Techniques to the Various Fields of Earth Science, discusses applications of aerial-photographic techniques to engineering, geology, geophysics, agricultural surveys, forestry, botany, and ecology, urban, regional, and military studies.

Three appendices deal with the air-borne profile recorder, a basic system for designating map units on aerial photographs, and integration of photogrammetry and electronic computation in highway engineering.

2-3139. Scherz, Gustav. **NIELS STENSEN IN COPENHAGEN. A HISTORICAL REVIEW OF THE LIFE AND ACCOMPLISHMENTS OF A FAMOUS COPENHAGEN-BORN SCIENTIST**: GeoTimes, v. 5, no. 1, p. 10-17, 56-57, illus., port., maps, July-Aug. 1960, 9 refs.

Some of the outstanding contributions of Niels Stensen (1638-1686) include in anatomy, the discovery of the duct of the parotid gland; in paleontology, the true significance of "glossopetrae" as fossil shark teeth; in stratigraphy, the principle of the original horizontality of sedimentary formations; and in mineralogy, the constancy of interfacial angles of crystals. Copenhagen was Niels Stensen's birthplac this and 18 other points of interest in the city as related to this scientist are described.--M. Russell.

2-3140. U.S. National Laboratory, Oak Ridge, Tennessee. **HEALTH PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1959**: U.S. Atomic Energy Comm., [Pub.] ORNL-2806, Contract W-7405-eng-26, 221 p., Oct. 1959.

Waste Disposal Research and Engineering. Operation of the process waste water treatment plant resulted in the lowest annual discharge on record of radioactivity to White Oak Creek. A study was made of optimum treatments for the removal of Cs-137 and Sr-90 from process wastes. Data are included on studies of soil disposal facilities; dispersion of radioactivity from White Oak Creek in the Clinch River; the development of an improved well probe for radiologging use; studies of waste burial areas; ecological studies in White Oak Lake bed and forest sites of the reservation, combined with studies on the movement and accumulation of radionuclides in vegetation and herbivorous insects; foliage contamination by local and regional fall-out; the containment of fission products by clays and vermiculit Cs-137 fixation by ion exchange; theoretical considerations and laboratory and field investigations of radioactive waste disposal in cavities in natural sal formations; investigations of the disposal of radioactive wastes into deep wells; an evaluation of hazards associated with tank storage of highly concentrated radioactive wastes; and the selection of a site for a tank form.--C.H. (courtesy Nuclear Science Abstracts, v. 14, no. 3, p. 344, Feb. 15, 1960. Publication not seen by AGI).

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